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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Sixth Annual Meeting, Michigan Gas Association.

OFFICE OF THE SECRETARY, SAGINAW, MICH., Jan. 11, 1899.

To the Members of the Michigan Gas Association: Gentlemen—The Sixth Annual Meeting of the Michigan Gas Association will be held in Lansing, on Wednesday, the 22d, and Thursday, the 23d, of February, next. Location of headquarters and list of papers to be presented will appear in next issue. Respectfully, HENRY H. HYDE, Secy.

[OFFICIAL NOTICE.]

Change of Meeting Time, Western Gas Association.

WESTERN GAS ASSOCIATION, OFFICE OF THE SECRETARY, NEW ALBANY, IND., Jan. 10, 1899.

To the Members of the Western Gas Association:

On account of the inclement and disagreeable weather usually prevailing in Milwaukee during the month of May, the Board of Directors, acting upon the advice of the Entertainment and Executive Committees, have unanimously voted (with the exception of Mr. Littleton, who is in Europe), to change the date of the next annual meeting of the Western Gas Association, from May 17, 18 and 19, to June 14, 15 and 16.

Members of our Association, and all who may desire to attend our next annual meeting, will govern themselves accordingly.

JAMES W. DUNBAR, Secretary.

BRIEFLY TOLD.

ALTERING THE WESTERN ASSOCIATION'S MEETING TIME.—The above official notice from Secretary Dunbar really explains itself; and while it may be thought that the prescribed change is an odd one, nevertheless the conditions which brought it about may not be fairly gainsaid. The announcement that the weather conditions in Milwaukee during May are unserviceable may reflect somewhat on Mr. Cowdery and upon Mr. Bredel; but that is only the Association's official way of putting it. The underlying cause for the change in the meeting time is that the "G. A. R." proposes to "camp" in Milwaukee during the week that the Western Association would have in due order convened, and as this is a warlike spell in our government, the gas men naturally retire in favor of the army—and for their own comfort. So far the outlook for the meeting is that it will be even of a higher order than any of those which have gone into history. Under the conditions we hope and believe that President Thompson, who has as a subaltern done very much for the Association, will, as its chief officer, be accorded that representation numerically from the membership at the meeting, which his work on its behalf deserves. The Hotel Pfister is to be headquarters, session hall and banquet room, which simplifies to the last degree the comfort of those who are to share in the benefits and pleasures of the Western's 22d meeting.

DEATH OF MR. JOSEPH PEARSON GILL.—We regret to report the death of Mr. Joseph Pearson Gill, who died, at his home in this city, the morning of the 9th inst. Deceased, who was a frequent contributor to our columns, and who had been prominent in American gas engineering circles for two score years, was in his 80th year. Next week we hope to give some connected record of his career.

NOTES.—Messrs. B. C. Ball and W. H. Corbett—the latter is a son of Mr. C. H. Corbett, of the Continental Iron Works—have formed a partnership, under the title of Ball & Corbett, with offices at No. 39 Cortlandt street, New York. As their announcement states, they propose to devote their entire time to consulting and contracting engineering in its various branches, including mechanical engineering. We are satisfied that each of the named gentlemen is quite up to completely meeting any demand that may be made upon him for service along the lines indicated, and our hope is that they will always have plenty to do.—— At the annual meeting of the City Gas Company, of Trenton, N. J., the officers elected were: Directors, H. C. Taylor, George S. Grosvenor, Henry W. Green, Edward W. Evans, Lewis Parker, Isaac F. Richey, Thomas S. Chambers and Edward H. Stokes; President, Isaac F.

Richey; Secretary and Treasurer, John S. Chambers.——At the January meeting of the Board of Directors of the Louisville (Ky.) Gas Company the dividend for the half year was declared at 2½ per cent., thus putting the stock on a 5 per cent. per annum basis. The matter of any change in the executive management was not discussed, all propositions hinging thereon being reserved for action at the Company's annual meeting, which will be held next month.——The proposition to establish a gas supply for Stockton, N. J., and the adjoining territory, is again being considered. Colonel Pfeiffer is said to be the moving spirit in the plan, and the Colonel is furthermore on record with the belief that $1.25 per 1,000 cubic feet is a selling rate that would yield profit to the gas suppliers and be acceptable to the residents. Our own belief is that Stockton will not have a gas plant for some time to come, and our further idea is that Lambertville is the natural point from which Stockton should obtain its gas service when the proper time arrives.——"A. T. R.," writing from Bloomfield, N. J., under date of the 8th inst., says: "The exact selling rate for gas in the Bloomfield and Montclair districts of the Newark (N. J.) Consolidated Gas Company is: Gross, per 1,000 cubic feet, $1.60; net, for prompt payment, $1.50."——The capital stock of the Bay State Gas Company, of Delaware, has been increased to $100,000,000. There are several ciphers in that enumeration.——The Peoples Gas Light and Coke Company, of Chicago, is said to have secured the leasehold (the latter runs for a period of 198 years, from May 1, 1891, the rental being $5,500 per annum) of the site and buildings, 154 and 155 Michigan boulevard. These premises adjoin, on the north, the present offices of the Company, which are located on the northwest corner of Michigan boulevard and Adams street.——The issue of the *Railroad Gazette* for the 6th inst. contains an article bearing the caption, "Why the Gas Tank Failed"—the article discusses the collapse of the Consolidated Gas Company's holder at 20th and 21st streets, this city, the afternoon or evening of December 13th, 1898. The writer of the article was Mr. George Rae, M.E., and it must be said of Mr. Rae that he has the courage of his convictions. But we very much fear that such expressed convictions will in the long run only serve to convict Mr. Rae of having rushed in on ground where less enthusiastic C.E.'s would fear to stand. Mr. Rae modestly says: "A critical presentation of some plainly apparent defects in the design of the tank will demonstrate to the technical reader that there is no need of resorting to the explosion or shock theory to discover the cause of failure, nor to the equally unnecessary suppositions that the material used in the tank was defective, or that the foundation was inadequate and settled unevenly." Then Mr. Rae goes on with his "critical presentation," which, when completed, causes one to speculate whether or not the "M.E." that accompanies his signature stands for mechanical, mining or marine engineer. Marines, of course, and justly so, are in great favor just now, because of their valorous acts during the recent disturbance between the United States and Spain; but the part of land engineers, in connection with mishaps on earth, would seem to lie in the direction that investigation should precede, which event would preclude divulsive judgment. The main recognizable facts in the holder collapse are that neither the Company nor the contractors can so far even convulsively show cause to the other why the disaster occurred. In connection with the investigation now underway, which those interested in the gas business may confidently hold will be minute, thorough, complete and impartial, we have to say that the inquest under the direction of the coroner has been postponed from the day—last Monday—named in the JOURNAL of a week ago.——At the annual meeting of the Hartford (Conn.) City Gas Light Company the Directors chosen were: John P. Harbison, James L. Howard, Hugh Harbison, Francis B. Cooley, Henry K. Morgan, Atwood Collins, George Roberts, Henry A. Redfield and Nathaniel Shipman. The reports of the officers showed that the Company had completed, in the last twelvemonth, the banner year of its history.——We are indebted to Mr. Carter H. Page, Jr., for a set of calendars and a brace of "booklets," which compilations are being judiciously distributed in Philadelphia by the United Gas Improvement Company, with a view to the sensible instruction of its consumers there as to the advantages of gas for lighting, cooking, power and heating use.——We are in receipt of a copy of the first number of "The Technology Review," which is a "Quarterly Magazine Relating to the Massachusetts Institute of Technology." It is a handsome magazine, and, better still, the matter between its covers is altogether up to the style of its binding and typography. The Editor of the "Review" is Mr. Arthur Thomas Hopkins, and the members of the Committee on Publication are Messrs. Arthur D. Little ('85); Calvin F. Allen ('72); James P. Munroe ('82). Every "Grad." of the Bay State "Tech." should hasten to enroll himself on the subscription list. Send along your order to Mr. A. T. Hopkins, 71 Newberry street, Boston.

[Concluded from page 11, Jan. 2, 1899.]

The Solution of Solids and Liquids in Gases.

By M. P. VILLARD.

V. *Critical Phenomena.*—If chloride of ethyl, for example, is put in the presence of compressed formene, we notice that at 200 atmospheres and 17° the surface of the liquid loses its distinctness and becomes transformed into a zone of transition several millimeters thick. On agitation the two fluids form a homogeneous mixture. This phenomenon is in every way similar to that observed when we heat a liquid in a closed vessel up to its critical temperature. We have to deal with a true critical point, as already noticed by M. Cailletet in the case of liquid carbonic acid and air.

The pressure at which the surface disappears varies with the temperature. We can thus observe the phenomenon in two ways: 1st, by raising the temperature and keeping the pressure constant; 2d, by increasing the pressure while maintaining a constant temperature. For any given gas and liquid there will thus be an infinity of critical points, each corresponding to a definite temperature and pressure.

The explanation of these phenomena is very simple; the solubility of the liquid in the gas increases when the temperature or the pressure is raised. At any given temperature, if the pressure is sufficiently great, formene saturated with chloride of ethyl, for example, will have the same composition as chloride of ethyl saturated with formene, and the two fluids will mix; this is what takes place at 17° under a pressure of 200 atmospheres; with sulphide of carbon and formene, at the same temperature, it is necessary to have a pressure of 550 atmospheres.

The phenomena observed in the neighborhood of this critical point are exactly similar to those observed in ordinary Natterer tubes; the cause is, however, different, and does not consist, as in these latter, in a want of thermic equilibrium; the results are, in fact, the same when the pressure only is varied.

The formation at the critical point of a zone of transition arises from the fact that the reciprocal saturation of the two fluids can only take place at their surface of separation, unless the diffusion is aided by agitation. It is thus only in the immediate neighborhood of the surface that the liquid and the gas can become of the same density; it is no longer so at a little distance away; this causes a continuous variation of the density, and of the index of refraction along the whole length of the tube. The analogy with liquefied gases is again met with in the appearance caused by condensation. If, for example, the pressure is lowered in a tube containing two fluids previously brought to the critical pressure, a simultaneous boiling and rain takes place; the resemblance with what takes place near the critical temperature in a Natterer tube which is cooled is complete. This phenomenon is easily explained, by releasing the pressure the liquid gives up a part of the dissolved gas, and *vice versa.*

VI. *Applications.*—The use of gaseous solvents furnishes a new solution of the problem of the distillation of bodies decomposed by heat. As a rule we have recourse to a vacuum when dealing with bodies of this nature; their boiling point can then be sufficiently reduced that, as a rule, decomposition need not be feared; but this process cannot evidently be applied to bodies so little volatile as stearic acid for instance. Another inconvenience of this method is, that at a low temperature the vapor tension is often very much reduced. The vaporization, it is true, is very active, but each liter of vapor represents only an insignificant quantity of material.

There would be a very great advantage in substituting for distillation, solution in a suitable gaseous medium. This is equivalent to considerably augmenting the volatility of the substance in question. By reducing the pressure of the atmosphere the whole of the substance dissolved would be deposited, the dissolving power of the gas becoming practically *nil.* This is a very great advantage over liquid solvents. The most volatile bodies being at the same time the most soluble, an operation of this character would give results analogous to those obtained by distillation, but it would be much more rapid, and could further be applied to bodies such as wax or paraffine, or even to explosive substances. The apparatus required would only be a reservoir of compressed gas and a few tubes of thick glass or metal furnished with taps.

This method of distillation is not only applicable to laboratory experiments. Compressed gas is now an article of commerce, and apparatus capable of withstanding pressures of several hundreds of atmospheres is easily obtained. There should, therefore, be no difficulty in adding compressed gas to the list of solvents employed in industrial chemistry.

The Pintsch Gas Plant, Manhattan Elevated Railroad, New York City.[1]

During the 15 years of its use in the United States, the Pintsch system of car lighting has met with remarkable success. This is due to the combination of efficiency in lighting and the employment of a gas which may be compressed and stored for transportation without material loss of illuminating power.

There are now about 85,000 railroad cars and over 4,000 locomotives using the system, and it is also applied with equal success in the lighting of buoys for marking channels in harbors and rivers. The buoy lights burn continuously from six to eight months, according to their size, without attention.

Pintsch gas is made from a high grade petroleum distillate, and is a fixed gas, which when compressed has an illuminating power six times as high as that of coal gas, known as "city gas," in the same condition. While city gas loses nearly all of its illuminating power by compression, Pintsch gas loses only about 10 per cent., and its candle power is about 65 when compressed to 14 atmospheres.

The process of manufacture liberates the gas from the oil, and it removes the tar and impurities by condensation and purification, after which the gas is compressed into storage tanks, and from them it is admitted to the distributing mains for charging the car reservoirs. In passing from the car reservoirs at a pressure of 12 atmospheres or less the gas goes through a regulator, which reduces the pressure to about one-third of an ounce per square inch at the burners, maintaining a steady, even flame, regardless of the varying pressure of the reservoir. It is a very ingenious device, and is one of the important parts of the system.

Forty Pintsch gas plants are now operated at the important railroad centers in the United States by the Pintsch Compressing Company. One of the largest of these has 30 miles of distributing mains, supplying 28 different railroads, and altogether these plants supply 1,200 Pullman, 500 Wagner and 10,800 passenger coaches on 110 different railroads. The plants are exceedingly compact and well arranged, the latest and most interesting being that installed 18 months ago at 159th street, New York city, for supplying daily 1,100 cars of the Manhattan Elevated Railroad.

The gas is made in a 2 story, 50 by 65 feet, brick building, and the whole plant, aside from the distributing system, occupies a ground space of about 60 by 136 feet. Besides being the newest plant, this one is interesting because of improvements in the retorts, which give a greater capacity with two fires than was formerly had with thirty. It also permits of better control of the quality of the gas. In general, the plant consists of the oil storage tanks, holding the raw material, a 50-gallon supply tank elevated inside the retort house, the retorts, condenser, exhauster, washer, purifiers, meter, gasholder, compressors, store holders for the compressed gas, and, finally, the distribution system. Fig. 1 is an exterior view of the plant; Fig. 2 is a diagram showing the process from the beginning up to the compression; Fig. 3 is a plan of the first floor of the building; Fig. 4 is the oil ends, and Fig. 5 the gas ends of the retorts; Fig. 6 shows the condenser and purifiers in a room over the compressors; Fig. 7 is the exhauster; Fig. 8 the compressors, and Fig. 9 a view of the valve gear of one of the compressors.

The oil supply tanks are underground outside of the building, and have a capacity for 25,000 gallons. A small pump in the retort house raises the oil to the supply tank as it is required, and from there it is sent by gravity to the retorts through graduated valves. The small tank is used to keep down the amount of oil in the retort house to the lowest terms as a measure of safety.

Formerly the retorts for Pintsch gas were of iron, and the improvement is in the substitution of clay. Clay retorts have been used for the manufacture of coal gas, and also to some extent for oil gas, but never before in this manner for making the gas used for car lighting. Clay withstands heat better than iron, and it lasts longer, but it requires continuous service, and is adapted only to plants of large capacity. These retorts may be made three times as large as iron for the same expense, and are economical because of the possibility of using fewer fires for the same work. Their use was to a certain extent experimental in this case, and it is now an assured success.

The retorts are of D section, 3 inches thick and 20 feet long, with a mouthpiece and self-sealing lid on each end. They are laid horizontally in two benches of six retorts each, and are heated by two coke fires in regenerative furnaces 30 inches wide by 6 feet deep, so designed as to heat the retorts evenly from end to end. The stoking door is at the floor level and in the center of the brick work, the ash pits being below the floor.

The hot gases from the fire reach the central portions of the retorts first, where they are mixed with a supply of fresh, heated air, inducing further combustion, which is completed by further additions of air at the top of the combustion chamber. The products of total combustion are led through flues to the chimney, their heat being utilized to heat the secondary air supply already referred to.

The oil is conducted from the supply tank to each retort by a separate pipe, with special devices for controlling its flow. Two of these connections are shown in Fig. 2, the others being omitted for the sake of clearness. After entering the retort the oil passes to the front through a 2½ inch pipe laid along the bottom of the retort. At the end farthest from the entrance this pipe has a return bend connection to a 4 inch pipe leading along beside the 2½-inch pipe to a point near the entering end, from which the gas is sent to the front again through the open retort. These pipes in the retort are turned up into a vertical plane in Fig. 2 in order to show them in the engraving. In reality, they lie along the bottom of the retort. These vaporizing pipes cause the oil to heat gradually, and they are necessary in order to vaporize the oil before it comes into contact with the clay. The adjustment of the flow of oil to the temperature of the retorts is important and requires careful attention in order to give a uniform product.

The gas leaves the front ends of the retort through 6-inch vertical cast iron pipes, connecting each retort to the hydraulic main overhead. The gas passes into the hydraulic main through dip pipes, the ends of which are 1 inch below the surface of the accumulated tar, and thus serve to prevent any passage of gas back into an unused retort. The level of the tar is uniform, the surplus above that needed for the sealing of the pipes being drained to a tank for storage. A safety valve, blowing off at 12 inches pressure, is connected to the end of the hydraulic main. A 10 inch pipe conducts the gas from the hydraulic main to the condenser in the purifying room located in the second story of the building. A running test for richness of the gas is applied by holding white paper before a jet from the standpipes leading from the retorts to the hydraulic main, the color of the stains made by the gas against the paper giving a measure of the quality of the gas.

In Fig. 2 the process of making gas may be followed. This engraving shows the system of pressure gauges, whereby the pressure at all points may be watched from the retorts.

The first step in the purification takes place in the condenser, which resembles a vertical tubular boiler, the gas passing inside and cold water outside of the tubes. It is seen at the left in Fig. 6. This removes all of the moisture and tar, and, in fact, everything that may be taken out of the gas by cooling. The tar and condensation drain off to the tar well. Fig. 6 shows the room in the second story of the building.

The use of clay retorts necessitates careful regulation of the pressure of the gas within them, and at this point in the process an ingenious and very effective exhauster is employed, shown in Fig. 7. This is a rotary wing pump driven by a steam engine, the throttle of which is controlled by a regulator so sensitive that it will maintain a pressure of 1 inch of water at all times in the retorts. The clay will not permit more than this amount of pressure, which makes this machine one of the essentials of the clay retort system. The machine works admirably, being entirely automatic. The exhauster passes the gas to the washer or scrubber, for removal of the products requiring mechanical operation. Here the gas is washed with water under a plate with ribs projecting downward, which cause the gas to bubble along in the water, finally passing through an outlet pipe to the purifiers. The washer is seen in front of the condenser in Fig. 6, and the purifiers are at the right, with the large covers, which may be lifted off by the chain hoists. In the purifiers the gas passes through large trays covered with lime or iron oxide for the removal of the sulphur. The gas then passes through a meter having a capacity of 8,000 cubic feet per hour, and goes to the gasholder outside of the building. It is then ready for compression, and at this stage tests of its quality are made by Hemple's method of absorption and by the photometer. The photometer room is well fitted up for testing the lighting power, a gas flame with a slit screen being used instead of standard candles.

The compressors, of which there are four, shown in Fig. 8, are excellent machines, worthy of a more extended description than the scope of this article permits. They were built by the Pintsch Compressing Company and are the outcome of long experience. The great care in the design and construction is manifested in their operation. A unique feature in the method of compressing at this plant is that it is done in two stages, with separate engines for each operation. This is done for the sake of economy in the number of machines and in the floor space

1. From *American Engineer and Railroad Journal.*

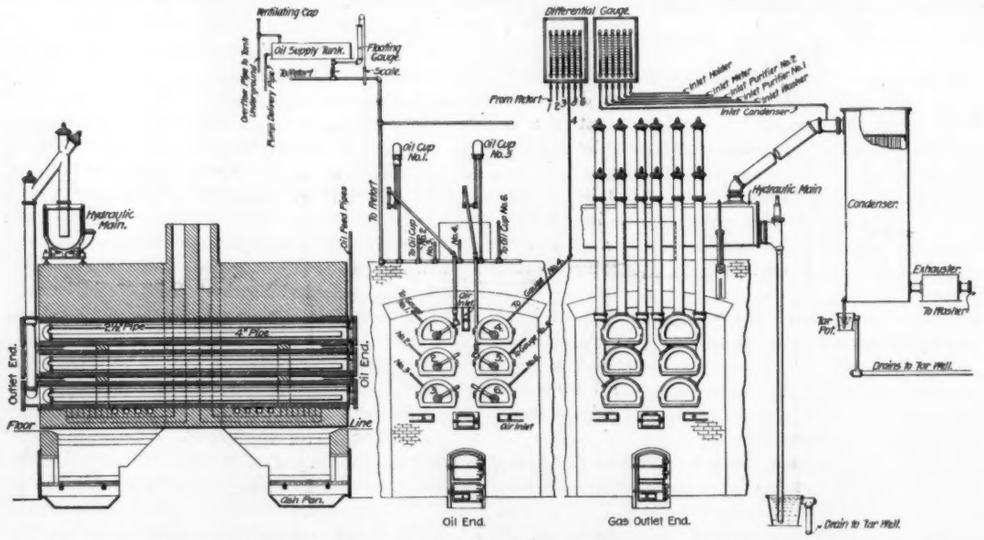


Fig. 2.—Showing Complete Gas Making Process. (This Engraving Shows Process as far as the Washer. See opposite page.)

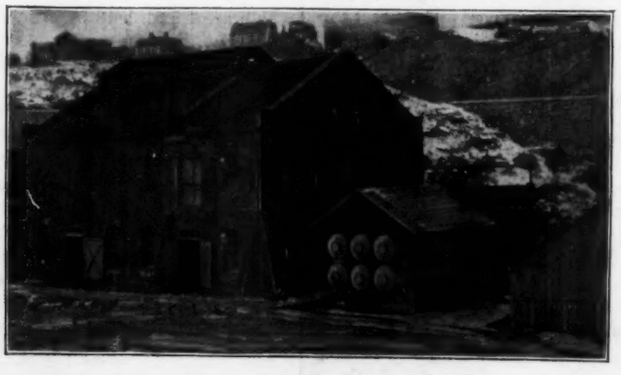


Fig. 1.—Exterior View of Plant.

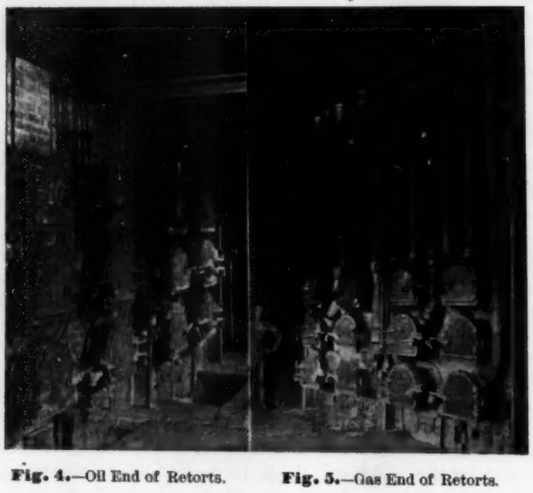


Fig. 4.—Oil End of Retorts.

Fig. 5.—Gas End of Retorts.

Fig. 6.—Condenser, Washer and Purifiers.

required, as well as economy in operation. All of the compressors are compound, the steam cylinders being all alike, with 6 and 12 by 18-inch cylinders. The gas cylinders are 7 by 18 and 14 by 18 inches. The steam is distributed by D-valves working on cylindrical surfaces and actuated by a single eccentric, an extremely simple valve motion (Fig. 9.) The gas cylinders are water cooled and have steel bushings. The inlet and outlet valves are in bonnets on the cylinder heads, and are accessible for inspection and renewal. The theoretical limit of the first compression is the square root of the total pressure, and the first stage in this case is about 3½ atmospheres, the pressure of the second stage being between 13 and 14 atmospheres.

The compression and cooling from the second stage deposit hydrocarbons, which are collected in pots outside of the building and under ground, from which they are sent to the small elevated tank in the right hand corner of the purifying room by the pressure of the gas.

Steam is furnished by an 80-horse power horizontal return tubular boiler, with a 75 horse power submerged tube vertical boiler as a reserve. After compression the gas is stored in five of the large welded steel store holders shown at the right of the retort house in Fig. 1. The sixth of these holders is used as a reservoir or receiver between the low and high pressure compressors. Each of the store holders has a capacity of 265 cubic feet per atmosphere.

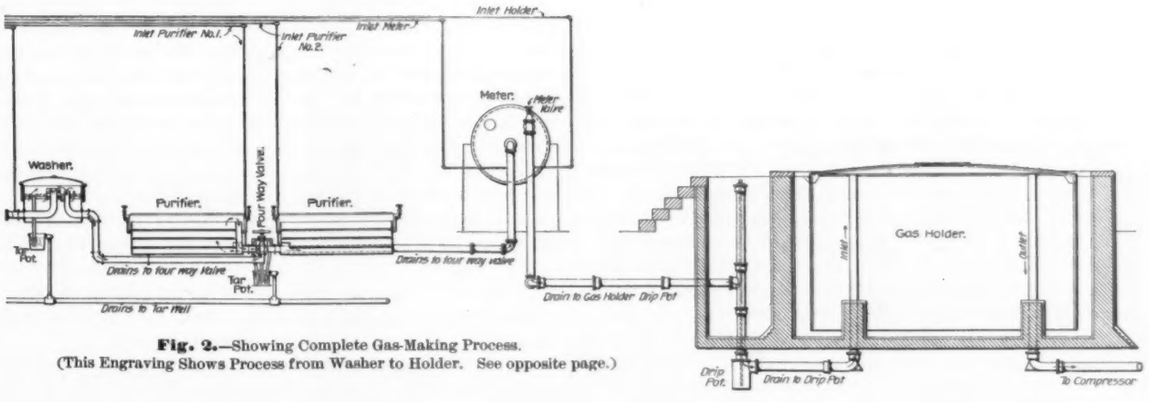


Fig. 2.—Showing Complete Gas-Making Process.
(This Engraving Shows Process from Washer to Holder. See opposite page.)

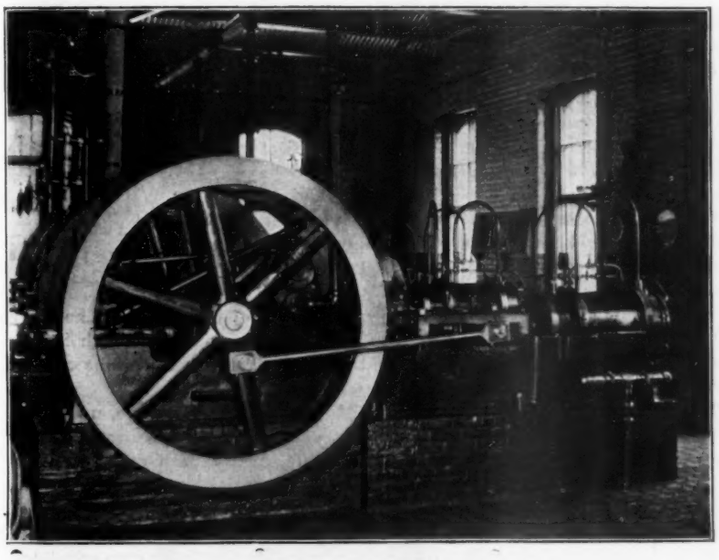


Fig. 8.—Compressors.

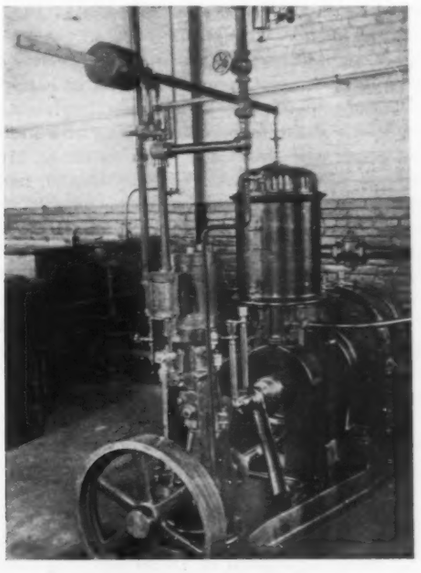


Fig. 7.—Exhauster.

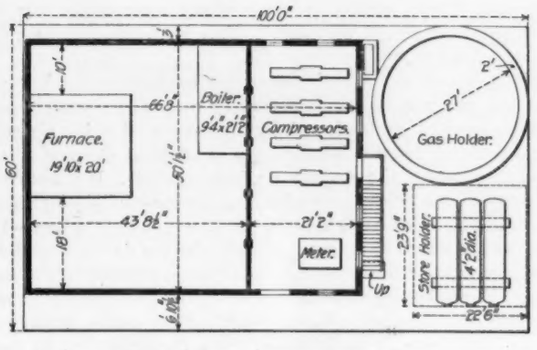


Fig. 3.—Plan of Ground Floor of Plant.

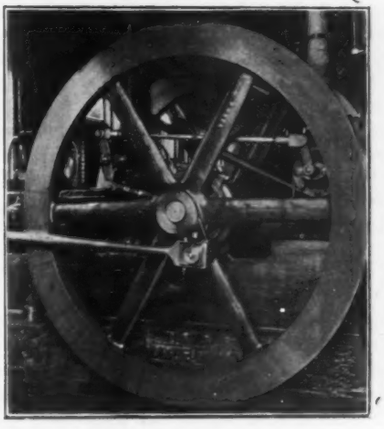


Fig. 9.—Simple Valve Gear of Compressors.

The plant has a capacity of 150,000 cubic feet of gas per 24 hours, and is the largest of the kind ever installed. It is arranged so as to provide for a reserve capacity of 100 per cent. for future extensions.

The piping system includes about 11 miles of extra strong 2-inch mains, all under a pressure of about 14 atmospheres. The mains have expansion bends, about a half mile apart, and are conducted along the elevated structure. In spite of the pressure and the extent of the line, there is a loss of less than 10 per cent.

The charging of the cars is done in five yards, and is performed with great rapidity by means of special hose fittings arranged for quick attachment and release. The chief charging stations are near the gas plant at 155th street, and at Second avenue and 129th street. A pipe leads to the yard at 145th street on Eighth and Sixth avenues, crossing over to Third avenue, where it returns to the 129th street station for the Third and Second avenue lines. The car lamps with clusters of ¼-foot burners give about 40-candle power each.

The Lecomte System of Bunsen Burner Construction.

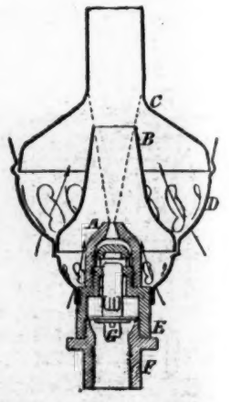
The *Journal of Gas Lighting* says it has been understood for some time past that the design of the Bunsen burner has a very great deal to do with the efficiency of an incandescent gas light. All the latest improvements of the Welsbach light have been concerned with the burner, as witness the Bandsept, Denayrouze, Kern and (in part) the de la Mare models. In the issue of the *Journal* for May 10 last (p. 1057) we described and discussed the Kern burner as representing the most advanced practice in the design of Bunsen burners for incandescent lighting; and we referred in the course of the article to Mr. Frank Livesey's demonstration of the importance of a thorough mixing of the air and gas for this purpose. We have now to call attention to the work in this field of M. A. Lecomte, whose "low pressure economical Bunsen burner" was deemed worth a prize of 500 francs by the Société Technique de l'Industrie du Gaz en France, at this year's meeting. As we have had a previous occasion to remark, it is by no means creditable to English gas engineering and mechanical science that in so many of these cases of modern inventiveness directed to the improvement of gas apparatus, the patentee is a foreigner. Englishmen do not seem to be doing anything at all worth mentioning in this particular regard.

M. Lecomte is associated in the patenting of his burner with M. Loeser, of the firm of Loeser, Ainé & Co., of Paris, whose regulator is used with the burner. It is hardly necessary to say how absolutely essential to the successful working of a burner of this kind is a proper regulator, and M. Lecomte regards himself as happy in having found an excellent rheometer, with an aluminum valve, satisfying all the exacting conditions of the successful working of an incandescent burner at the low pressure of 2 centimeters of water. A brief notice of this patent was published in the *Journal* for June 29, 1897 (p. 1503), and a statement of its performance was given as a "Note" on Oct. 5 the same year. In view of the prize award of the Société Technique, and the circumstance of the burner being actually introduced into the English market by Mr. A. Flürscheim, of 20 High Holborn (where specimens are on view), we have deemed it worth a more extended notice. We have inspected Lecomte burners of different sizes, working with incan descent mantles, at this address. At as little as 4 tenths of water pressure, the mantles of burners rated at 2, 3, 4 and 5 cubic feet of gas consumption per hour were kept fairly bright, which, of course, was vastly improved by increasing the pressure to (say) 14-tenths. A separate exhibit of high-intensity burners, driven at a gas pressure of 7 inches by a motive power meter actuated by a tiny hot-air engine, displays the higher range of efficiency of the Lecomte system; the reput ed duty of the mantles being 25-candle power per cubic foot of gas. The patentees claim that their burner will work perfectly, giving full light, at a gas pressure of 10 millimeters, with an economy of about one-third of the gas consumption of an old-pattern Welsbach burner. They claim also to beat the Kern burner on its own ground.

M. Lecomte's account of the principles upon which he has based his improved Bunsen is given in the form of an appendix to this year's "Transactions" of the Société Technique. It is an interesting and instructive essay on the Bunsen, treated with all the pomp and circum stance of a French scientific memoir, as an appliance for inducing the flow of fluids. The author sets out his problem to be solved in the plainest terms. He recounts how hitherto the usual kinds of gas burners in use have worked best at a low pressure; while the distribution of gas in the mains has also been kept at the lowest pressure that would suffice to supply the consumers' requirements, governed chiefly by the consideration of the needs of the burners in question. With the introduction of the incandescent gas burner, however, a different requirement arose, because this burner would not work satisfactorily at less than 25 millimeters pressure. M. Lecomte set about remedying this. First, he investigated the "ejector" part of a common Bunsen burner for incandescent lighting, and found it wrong in respect of the phenomenon of the *vena contracta*. Where the outlet hole is cylindrical, the stream of issuing fluid becomes contracted just outside the orifice; and it is the dimension of this contracted part, not that of the hole, which governs the rate of discharge. The discharge of such an orifice is only 60 per cent. of the apparent capacity of the opening. M. Lecomte accordingly makes his discharging orifice conical, with the object of realizing the phenomena of the *vena contracta* in the ejector itself, and not outside it. So much for his means of obtaining the utmost possible flow of gas for the pressure that may be available.

The next consideration is the mixing of the air and gas, which is a matter of *entrainment*. The idea is illustrated by the accompanying drawing of the Lecomte burner, in vertical section. This shows the conical ejector *A*, which is claimed to give the best results when the aperture is bored out at an angle of about 30°. As the gas issues from this orifice, it expands as shown by the dotted lines. In so doing, it draws in air, first underneath the cone *B*, which has an angle equal to that of the dispersion of the gas. The mixture of gas and air thus made is not perfect. It has not enough air. There is no penetration of the air, as burning, into the combustible. To effect this is the function of the second cone *C*. All this is a question of the shape and disposition of the ejector and the two cones. As the author says: "Here are the two essential principles of the construction of the Lecomte Bunsen: First, an ejector having the highest dynamic effect; secondly, a system of cones possessing the peculiarity that the widest cone is always uppermost, and produces, by the penetration of the aspired air into the interior of the gaseous mass, a very intimate mixture of air and gas." The governor is shown at *G*; *E* and *F* are the body of the burner and its connector.

As stated in the patent specification, the desired results "are only obtained on the express condition that the angles of expansion of the gas and of entry of the air be well observed." In practice, the arrangement of cones is covered by a perforated screen *D*, and lends itself well to the manufacture of a neat burner body. It is stated that by this means the gas draws in and mixes itself with rather more than five times its own volume of air. In order to burn this mixture at the required point, without firing back, a covering tube with a perforated or wire gauze cap is slipped over the top of the burner. M. Lecomte declares his object in devising his low pressure Bunsen to have been that of improving the incandescent gas light sufficiently to enable it to replace everywhere, under all conditions, the old Argand and flat flame gas burners. He admits that the mantles of the incandescent gas lights are nearly perfect things of their kind. The gallery of the burner is fairly good, and is not susceptible of much improvement. There only remained the Bunsen; and with this he evidently thinks he has done wonders.



The report of the Committee of the Société Technique, upon which M. Lecomte received his prize, states that for equal pressures his burners proved in their hands neither worse nor better than other well made incandescent burners, such as those of the Welsbach Company. What the Committee did find, as a specialty of M. Lecomte, was "that his economical low pressure burner worked normally, starting from a pressure of about 10 millimeters when fitted with its own regulator;" and that it "gave for consumption and intensity the same results as the Welsbach burners No. 2 and No. 3, which only began to work regularly at from 30 to 35 millimeters, and need a still higher pressure to yield their best effect. * * * The Bunsen of M. Lecomte realizes, therefore, the advantage of yielding at the lowest gas pressures usual in a town the same results as the best incandescent burners in the market. These results do not sensibly alter under the influence of ordinary changes of pressure." This is the merit recognized by the Société Technique.

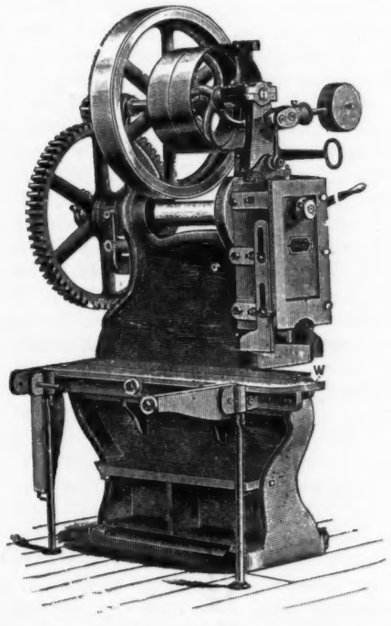
With regard to the high power gas burners on the Lecomte system, we can but record the fact that by means of a motive power meter, driven as already mentioned by the agency of a hot air engine deriving its energy from a flame of gas, a brilliant show of lighting, rivalling the effect of the electric arc, is producible. It is not for us to criticise these high power gas lights, nor the means by which they are kept going. There is this to be said for the Lecomte system—that the inventor has a neat arrangement, whereby the delivery of the gas under pressure automatically adjusts itself to the number of the lights in service. There are many devices with the same object in the market; and we welcome them all without awarding preference to any on the faith of an experimental installation. We do not know, by the way, that any factory or workshop has adopted one of these systems on its merits. For street lighting, M. Lecomte has a neat device upon the principle of the "trombe," or water blast, which can be put into the base of a street lamp column and arranged to maintain from 1 to 3 high power burners, each giving a light of 300-candle power, for the expenditure of 5 gallons of water per hour. Thus it will be seen that Messrs. Lecomte and Loeser have a very complete equipment of gas burners and accessories for popularizing the incandescent system of lighting in the house, the factory and the street. Whatever may be the absolute and comparative merits of these specialties, they at least go to show that the

use of gas for lighting purposes under different conditions is being progressively developed, with every regard for consumers' requirements.

It may be a weakness, but we do experience a feeling of regret that this work should be so completely abandoned to foreigners. It would be much more satisfactory if these improvements in gas burners and their accessories did not all come from France or Germany, where the conditions of the gas industry are not the same as we have in England. At a time when so much is being said concerning the successful rivalry of foreigners with British manufactures, it is very discomposing to find the English market flooded with gas apparatus that owes nothing to English ingenuity. Where is this kind of thing going to end? Is the manufacture of gas specialties about to die out of the land; and is British gas to be burnt always by the aid of French or German fittings and appliances? These are serious questions, and we cannot suggest a satisfactory answer for them. Meanwhile, it is something to be thankful for that the Frenchmen and the Germans are able to show us how to burn gas to the best advantage.

The Bertsch Universal Plate Shear.

Messrs. Bertsch & Co., of Cambridge City, Ind., are putting on the market a device known as the Bertsch universal plate shear, a very fair idea of the plan of which may be gained from a look at the accompanying illustration. It is made with 10 to 16-inch blades for trimming and slitting ¼ inch to ¾-inch plates. It is also arranged for cutting



angle iron and for punching, if desired, the throat being 8 to 15 inches. The knife head has a long bearing in substantial guides, and full provision is made for taking up wear. The extension side table, with its bracket arms, is provided with friction rolls for ease and convenience in shifting the plates. The table and arms can be quickly turned down and the latter can be made any required length. The casting in the rear of the blades is extra wide to insure strength, and there is ample clearance for shifting the cut metal. The main frame is also provided with a heavy strengthening bolt in the rear of the throat. The gearing and driving pulleys are entirely out of the way.

Notes on the Distribution of Alternating Currents.

By Mr. S. E. T. Ewing, in *Elec. Engr.*

Great diversity of opinion exists among engineers as to the best and most economical methods for the distribution of alternating currents. In a few years' time no doubt as great uniformity will obtain as is now the case in continuous current work, but at the present the variations of opinion and practice are very striking, hardly two stations in the country being alike, save perhaps when they are the work of the same firm throughout, and have not been subjected to the ideas of an independent consultant. The following notes are intended to indicate the apparatus and methods in most general use, with such comment as seems likely to be of service to readers:

General Conditions of Economy.—From the point of view of economy, the general aspect resolves itself into the just proportioning of the interest charges on the capital cost and the cost of generating the units lost in distribution. Naturally many factors enter the question which render the best solution in individual cases very difficult to decide. Two examples exhibiting very different conditions may be cited. The one is a company whose compulsory area is very large and scattered, and whose available capital at the outset was unduly small. In this case the only way open was to put down high-tension distributers in conjunction with house transformers. This was done and enabled a start to be made on a fairly paying load, drawing chiefly from a residential district, and for some years a good dividend has been paid. At the present time, however, the ratio of the number of transformers in circuit to that of consumers is as one to three, and as most of the transformers are of the old make and poor design the magnetizing load (true watts) is nearly 9 per cent. of the maximum load on the station. The other example, offering a very complete contrast, is the undertaking of the corporation of a rather densely populated town about the same size as the above. In this case the consulting engineer, having plenty of capital at his command, arranged for some 13 well-equipped sub-stations in the central area, and a network of low tension mains in all the principal and secondary streets of sufficient section to meet any probable demand for several years to come. A number of large transformers were also installed, whose capacity far exceeded the demand after the first 18 months of working. The load taken up during this period being chiefly supplied to early closing shops and offices—comparatively unremunerative customers — the undertaking has been heavily handicapped by the large interest charges. Thus in the former of these two instances an arrangement of plant which cannot be recommended in the abstract has enabled a profit to be made under circumstances which would have debarred a more efficient, and therefore more expensive, system from doing so; while in the second the adoption of a very efficient and permanent plant has resulted in an immediate loss where a more modest beginning, with a more elastic system, would undoubtedly have enabled a profit to be made from the outset. Under any circumstances, however, it is desirable to have a good deal of flexibility in the distribution arrangements—that is to say, ready means of enlargement to meet the increasing demand that experience has shown may be always expected, without unduly burdening the undertaking in its early days.

High Tension Feeders.—High tension cables are perhaps the part of the distribution system which the engineer most fears, though now-a-days to nothing like the extent of a few years back. The failure of a feeder means in many cases the total extinction of a large number of lights until a repair can be effected, and unlike the low tension mains, which can easily be arranged to help each other, the failure of a high tension main is difficult to economically safeguard. A good deal has been written of how high tension feeders should be duplicated and interconnected, arranged on the ring system, and so forth, but in these suggestions a cardinal point is often lost sight of. A high tension system is adopted in most cases—though not in all—less on account of the intrinsic beauty of high tension than because it enables the supply station to be moved to a considerable distance from the area of supply to the site most favored as regards the supply of coal and water and freedom from liability to injunction. Hence, high tension mains are often so long that their capital cost approximates power for power to that of the shorter low tension feeder, and complete duplication is too costly to bear consideration. In this, as so many other questions in which absolute security has to be balanced against cost, a compromise is the best solution. Two sub-stations lying fairly close together, each fed by a separate feeder, may be interconnected by a main of the same section as the larger of the two feeders. A breakdown will then mean more or less irregularity of voltage over the area supplied by the two sub-stations, but the period of total extinction need only last until the requisite connections between the sub-stations has been made. The use of a "discriminating cut-out" would even prevent the extinction, but at present there is but little experience available as regards this accessory, which promises, however, to be a most valuable invention. If the low tension mains fed from each sub-station are permanently interconnected, or if arrangements allow of so connecting on emergency, the voltage variation may be still further lessened. Nowadays makers are willing to guarantee their cables over a period of years, and undertake to repair all faults at their own expense during this period—a proviso of singularly small use to the user, for a cable breakdown has in nearly all cases to be repaired by the station staff within a few hours of its occurrence. Cables are always tested at the makers' works after many hours' immersion in water at something like five times

the working pressure. If they are then carefully laid and jointed by men experienced in the particular class of cable, and subjected to a further pressure test to try the joints and end connections, they may be relied on not to fail for electrical reasons with considerable certainty.

The all-important thing in the case of heavy cables is that they should not be unduly strained or otherwise injured during the drawing in, and if the insulation is hygroscopic, that great care be taken that the joints and end connections are kept free from moisture during the making and sealing up. Large cables are very heavy, but are easily damaged by straining, so that the use of a winch for drawing them in is to be deprecated. Half a dozen men pulling on a rope can only exert a limited force, and experience will enable the cable layer to judge whether a given length and weight of cable is offering more than normal resistance, which may be due to inequalities in the conduit, and whether it is safe to employ more weight on the draw rope. Breakdowns on good present day cables are generally due to mechanical injury, such as the bursting of water mains, the crushing of conduits by road engines, workmen's picks, and so on—accidents against which it is not possible to thoroughly guard. The broadest distinction in cables is that between the ordinary double and the concentric class. Between these two lies the twin cable, consisting of two separate side by side conductors, made up in one sheathing, and having a slow twist round each other. The latter may be said to be electrically nearly equivalent to the ordinary double cable and mechanically equivalent to the concentric. There are some striking differences in electrical behavior between these two main classes of cable. The double conductor has more self-induction for a given length and less capacity than the concentric. With small currents the inductive drop is not important, but with large currents, and when drawn into iron pipes, it becomes a factor to be reckoned with. With currents amounting to several hundred amperes its use becomes impossible for distribution work. On the other hand, on long lines the capacity current of a concentric cable comes into prominence, especially as it varies directly as the impressed voltage.

Most readers will be aware from published statements that the capacity current of the Deptford trunk mains, having a length when looped of nearly 12 miles, is between 12 and 14 amperes at the working pressure of 10,000 uolts. This current, though wattless, has to be allowed for by increased section of copper in mains and generating machinery. The behavior of twin cables comes between these two classes. Their inductance is lower than that of a double conductor, and their capacity higher. They are largely used in systems where a quantity of double cable has been already installed, for the reason that it is inadvisable to use a combination of double and concentric mains. The capacity between the outer conductor of a concentric main and the earth has the effect of lowering the potential of the outer to the neighborhood of the earth potential. Connected to a system of double conductor mains, the potential of one main is thereby brought nearly to earth potential, whereby the difference of potential between the other main and earth is nearly doubled. This has generally been found to produce disaster. In cases where nothing but concentric cable is in use it is becoming usual to connect all the outers to earth at the station switchboard, arrangements being made that they can be disconnected singly for testing in compliance with the Board of Trade regulations. For ease of handling, and ease and cheapness of jointing, the ordinary double rubber insulated cable decidedly takes first place. Concentric joints are rarely satisfactory unless they are made in a special joint box. Hence, a multiplicity of joint boxes of different sizes and shapes have generally to be kept which, being usually the makers' patents, are costly. The earliest were insulated with vulcanized indiarubber, and the trouble experienced some years ago has, it is to be feared, greatly prejudiced engineers against indiarubber as a dielectric for this class of work. Yet at the present time rubber covered cables can be obtained of great reliability, and their use offers many advantages for small feeders. Being very light and flexible, they can be drawn in for considerably greater distances than lead covered cables.

Jointing is simple and rapid, and no special boxes or end connections are required. However, the price of rubber is rising so rapidly that at the present time a lead-covered paper or jute-insulated concentric cable is considerably cheaper than two rubber insulated cables of the equivalent section, and it cannot be denied that they are fast falling out of use. The other dielectrics most in use are paper from which all traces of moisture have been removed, impregnated with a heavy hydrocarbon oil, and fibrous material, such as jute, impregnated with special insulating compounds of a bituminous nature. Both these latter classes are protected from moisture by a solid-drawn sheath of lead, which is further protected by a serving of tape and preservative compound. Paper insulation is extremely weak mechanically and very hygroscopic, but so excellent is the manufacture of these cables that immense quantities have been laid and are working successfully. Of late a decided preference has been shown for armored cables, which can be laid direct in the ground without further covering than a tarred board to notify the whereabouts of the cable when the ground is opened for jointing or repairs, and it is fondly hoped to warn off the ubiquitous navvy's pick. An armored cable costs rather less than one of similar make and cross-section, lead-covered, and an iron or earthenware conduit, but it is difficult to see that this fact justifies their use in all cases. The possibility of drawing out faulty lengths or lengths of insufficient section, rapidly and without disturbing the streets, is very valuable, particularly when the undertaking is in the hands of a private company and the town authorities are apt to look askance at frequent requests for permission to open roads. But in spite of this great drawback its use is undoubtedly extending rapidly.

In the great majority of cases at present no provision is made for counteracting the drop in pressure in the high tension feeders at full load, beyond raising the bus-bar pressures slightly during the full load period. At best this method can hardly be considered fully to meet requirements, and in future design there can be little doubt that a transformer with variable change ratio, or some equivalent device, will have to be placed in each feeder circuit, in which case the station pressure would be kept constant at the value necessary for the shortest or lightest loaded feeder. An important point to which little attention is usually paid is the safeguarding of men working on mains which are usually kept alive. The procedure in many stations is something as follows: The electrician in charge of mains telephones or sends a message to the engineer at the station asking him to take off a particular main or circuit, and when he is satisfied that this has been done he tells the jointer to proceed to work on that main. If by mischance the main was not taken off the bus bars, or was afterward put on prematurely, or the jointer cuts the wrong main, the responsibility may be difficult to fix upon the right person. Nothing can be better, however, than the method adopted in some stations whereby the jointer, having received his orders, goes himself to the station, and, with the permission of the engineer, opens the switch and places a wooden panel over the recess, which he padlocks, taking the key away with him. When the job is finished he goes back to the station and gives up the key. A main may sometimes be fed from both ends, and in this case some engineers provide a short-circuiting plug between the inner and outer at the sub station or transformer pit, and make it a rule that this plug shall always be inserted before any work is done. The outer main is of course permanently earthed at the station.

[To be Continued.]

The Protection of Metal Work.

Engineering Record says that a lecture on the "Durability of Structural Materials" was recently delivered before the students of engineering at the University of Wisconsin, by Prof. A. H. Sabin, of Edward Smith & Company, New York City. It was largely a statement of his views on the best methods of protecting metal work, a subject of such general interest to engineers and architects that advantage is taken of the courtesy of the *Wisconsin Engineer* to print the address in these columns.

They say there are oak timbers in the roof of Westminster Hall which have been in use 1,000 years. In the village where I live there is a meeting house which has been regularly used more than 200 years, and dwelling houses built a generation before, that are still regarded as desirable residences. For all that, houses 100 years old are rare, those which are 50 are usually pretty well worn out, and very many houses and barns entirely disappear in 25. So we see that the durability of structural materials must depend in a great measure on the conditions in which they exist, and particularly on the care taken of them.

Iron, especially in the form of steel, has within a few years become a comparatively cheap and common building material; and in view of the fact that important iron structures have been almost completely destroyed by rust in as short a time as 25 years, and single members of structures have lasted from 1 to 5 years only, the question of its preservation becomes one of importance. I suppose that few bridge engineers think a steel bridge is likely to last 50 years, and if it is possible to make a steel structure last from 200 to 1,000 years it is worth while to know how to do it. As a matter of fact, we really know a good deal more about the preservation of iron than we do about the preservation of wood. The latter is subject to attacks by fungi, bacteria,

various insects and other forms of animal life; the former only by chemical agencies, and in a few comparatively well known ways.

Practically the only things which attack iron are oxygen, sulphur, and, to a limited extent, carbonic acid. Sulphur acts in the form of sulphides and sulphates, and all act in conjunction with water, which is in most cases necessary to chemical action everywhere. It certainly seems as though we ought to be able to check and prevent chemical action when it is of such simple and well-understood kinds; at all events that we should not shut our eyes to it.

The first thing to do, and it is also first in order of importance, is to prepare the surface of metal. If this is very rusty it is practically useless to paint it; if covered only with black scale there is no doubt that advantage is derived from the use of a good paint, which in these cases affords considerable, though incomplete, protection to the metal; but if the best results are expected the whole of the scale, which is usually oxide, must be removed, so that the paint may be applied to the surface of the metal. This may be so difficult and expensive as to be unprofitable. It may be cheaper to do a less durable job and replace the structure after a time, or the structure may be a temporary one; but if the best results are sought it is necessary to clean the surface perfectly. This may be done by the sandblast or by pickling in acid, or in case the pieces are not too large by grinding the surface on an emery wheel or belt, or by scraping and filing; and when it is done the paint must be applied immediately. If there is any delay a film of oxide (probably hydrate) will form, to get rid of which all the previous work was done. When this first coat is properly applied the most difficult and costly part of the work is done.

But suppose, as is the case with most work, you do not find it practicable to secure such a perfect surface, what then? In the first place, examine the surface carefully and note all the rusty places. Have a lot of scrapers made, some of them broad and flat, others narrower, some quite narrow; some of these should be bent like a hoe or rake, and some should have serrated edges, and all should be large enough so that the operator may exert a good deal of force on them; large and small chisels should also be at hand, and stiff wire brushes. With this outfit the surface should be vigorously scraped and scrubbed until the inspector is satisfied that all the scale which is at all loose has been removed, and that all rusty spots have been cleaned out as thoroughly as possible. A great part of the mill scale will resist this treatment; but it must be assumed that scale which adheres so firmly will not be dangerous if well painted, and at any rate all the dirt and grease have been scrubbed off.

Then apply a heavy coat of paint, and as soon as that is reasonably dry put on a second. Our common notions about painting metal are derived from painting wood, and are often fallacious, notably in the matter of a so-called priming coat. Suppose we are to paint a new, clean piece of wood with an ordinary pigment paint. The latter consists of a solid in the form of powder mixed with half its weight or thereabouts of linseed oil or other vehicle. If this paint is spread on the wood the oil is absorbed quickly, leaving the pigment on the outside with so little cementing material that it will brush off when it gets dry. Obviously the remedy is to mix a special paint for this first coat composed of nearly all oil with a little pigment; the oil serves to fill the pores of the wood, so that the next coat of paint will be applied to an impervious surface—or for that matter the first coat may be oil alone. This first coat of very thin paint is called a priming coat. Now, when the house painter who has been carefully trained to this routine is set to painting an iron bridge, he proceeds to apply a priming coat, just as thin as possible; and, incredible as it may seem, some of the large manufacturers make what they call a priming coat for metal. The whole thing is the climax of absurdity. The first coat of paint on bridge work should be as thick as will lie smooth and dry thoroughly; and the second should be like unto it. Nothing is likely to be more wearisome to the soul of an intelligent man than this talk about a priming coat on bridge work—except when it becomes amusing, as was the case when a paint manufacturer assured an engineer of my acquaintance that his paint would soak into an iron plate a sixteenth of an inch.

The paint should be applied only in dry weather, if it is used out of doors, but if it is new work the metal should be kept under shelter, and it is better if the building in which it is should be kept warm in cold weather, until the first coat of paint is dry. Surfaces which are to be riveted together ought to receive two heavy coats of paint, and this should be reasonably dry before riveting; if it is freshly painted the hot rivet will drive the paint away from the rivet hole, but if the paint is dry no such thing will occur. When painting is done out of doors, as is commonly the case with a second coat, it is often interrupted by storms. Recently I walked through a yard where such work had been going on and saw the paint buckets standing about where the driving rain could beat into them, and in one case I saw half a gallon of paint mixed with about 20 per cent. of water. This was enough to paint a very large post or girder; and when subsequent corrosion is discovered, as it is likely to be if inspection is made, the cause will be a mystery and the blame will probably be laid on the paint manufacturer. Many workmen are careful and intelligent; they are not the ones we need inspectors for. The inspector must assume that, as was shown in this case, there is nothing too stupid or careless for the workmen to do, or too tricky and dishonest for the contractor. I do not think that as a rule contractors are dishonest; but many are, and many of the rest are ignorant, which is, in its effect, nearly as bad. What the engineer is hired for by his client is to supply the scientific knowledge needed for the work. If the contractor has it also it is an excellent thing, but that does not release the engineer from the performance of his duty. In this matter the duty of the engineer is to select the best paint, according to his judgment, and see that it is applied properly. If he thinks a particular paint is the best he ought to specify it explicitly, and for that matter do the same with all materials. I have no patience with specifications which do not specify; the contractor does not know what he is to use; the owner is not properly protected; and the engineer is likely to be involved in endless disputes.

To protect iron or steel from corrosion it is only necessary to surround it with something which shall completely keep air, water and acid gases from its surface. If the metal were to be further protected from all agencies which would destroy this protective covering, and if the coating material itself were absolutely unacted on by these external agencies, the problem would be solved. But as a matter of fact, none of these desirable conditions is maintained. In the first place it may be doubted whether the preservative coating is ever quite continuous, though perhaps it may be practically so; but certainly it is liable to be removed by blows, scraping and attrition, and nothing has yet been discovered which will last forever. So we must apply the best coating material we can get, then watch it carefully and renew it whenever it is injured; and in this way I am inclined to believe that a steel structure may very well be made to last 1,000 years.

Suction or Pressure? The Principle which Underlies the Mode of Action of Pumps, Siphons, Barometers, etc.[1]

The question "How does a pump act?" is an old and oft-repeated one, and the answers to it are somewhat conflicting. Some say the pump does not work by suction but by pressure, and to sustain the conclusion as an invincible one, they state that there is no such thing as suction, never dreaming that the word is a name for an occurrence. It is a very old one, and has been and is now used to indicate what takes place when a solid or fluid is subject to a pressure on one side that is greater than that on the other. Many very interesting examples of suction pass under daily observation, such as the young sucking the teats of its mother, the peculiar action of the suckers on the tentacles of the cuttle fish, the sucking action that is the function of many of the organs of living bodies and many applications of sucking found in works of art, such as the suction produced when a hot glass is placed over a fleshy portion of a living body. A common experiment of this kind is to heat a wine glass until the temperature is about 200° F., and then quickly place it closely and tightly, mouth downward, on the fleshy portion of a man's arm, when, after the expiration of a few seconds, the portion of the flesh inclosed within the mouth of the glass is seen to swell up as an indication that the operation of sucking has so far progressed. Looking at what has taken place, a few queries are suggested to the mind of the investigator, and the first is, if the flesh was not sucked up, how has it been by any other means so raised? for it is evident that some force has acted upward from beneath the skin and produced the swelling under notice. It is clear, however, that no pressure exists beneath the skin that is perceptibly greater than the pressure of the atmosphere. It is evident, however, that locally the pressure of the blood and the other juices in the living flesh of a man's arm have been subject to a pressure superior to the pressure of the air within the glass, or otherwise the upward pressure producing the swelling could not have occurred. This last conclusion is strictly correct, for after the glass was pressed onto the man's arm it cooled, and the air it contained cooled, and as the temperature declined the pressure lowered, with the result that the man's skin was subject, from beneath, to the superior pressure of his blood, that was equal to that of the atmo-

1. From *Mines and Minerals.*

sphere, and above to the inferior pressure of the air that had cooled within the glass. That the pressures were different can be proved in a simple manner by Charles' law, which is that the pressure of a given mass of confined air varies directly as the absolute temperatures to which it is subject. Suppose, then, that the temperature of the air in the glass at the beginning of the experiment was 200° F., and that after it cooled and the swelling occurred, the temperature declined to 60° F., then if the pressure of the atmosphere was 14.7 pounds to the square inch when the temperature of the air was 200° F., it would fall to 11.58 pounds to the square inch when the temperature declined to 60° F., for $\frac{14.7\ (460 + 60)}{460 + 200} = 11.58$ pounds. The pressure then within the glass is less than the pressure without by $14.7 - 11.58 = 3.12$ pounds, and if the area inclosed by the lip of the glass was equal to 1 square inch, the glass would be pressed on the flesh with a force of 3.12 pounds. Observe, however, that the flesh protruded, that is, swelled, and in doing so reduced the volume or contents of the space occupied by the air. Suppose then the contents to be 1.5 cubic inches and the protrusion to be equal to .25 of a cubic inch, then the pressure causing the glass to adhere would be reduced, because the pressure within the glass would be increased, as by Boyle's law, the pressures of elastic fluids, when confined and their temperatures are constant, vary inversely as their volumes; here, then, the pressure within the glass would be increased as the result of the reduction of volume for $\frac{11.58\ (1.5)}{1.5 - .25} = 13.896$ pounds, and the actual force pressing the glass on the flesh after protrusion would be $14.7 - 13.89 = .81$ pound. It is evident then that after protrusion the force pressing the glass on the flesh, or otherwise, the influence of suction, would be just a little under 13 ounces. In this example, as in many others of a like character, suction is the result of a local depression into which something can be forced by the superior pressure of the atmosphere. To say that a pump works by pressure is only partially correct, as the inflow into a pump only takes place after a depression has been produced. It is plain then that the word suction is a necessary one, as it specifically refers to the pressure of the atmosphere. The zero of suction occurs when the opposite sides of a solid or fluid are each of them subject to the total pressure of the atmosphere, and the maximum of suction occurs when no pressure is exerted on one side of a solid or fluid, while the total pressure of the atmosphere is exerted on the opposite side. In short, the maximum of suction is found when an opposite side or end of a solid or fluid is situated in a vacuum. The mercury barometer furnishes an example of maximum suction, as in it the whole pressure of the atmosphere is exerted on the lower end of the column while the upper end is in a vacuum. It is unusual to say that the tube of a mercury barometer sucked up the mercury, nevertheless, it would be as correct to apply the word suction to the force by which mercury is pressed into a vacuum tube, as it is to apply it to the siphon or the pump.

In a mercury tube all air is expelled by filling it with mercury, and then taking care during the inversion of the tube, to prevent the possible re-entry of air, so that when the column of mercury subsides to the height that corresponds with the pressure of the atmosphere, a perfect vacuum should characterize the space out of which the mercury has fallen, surely then this is an example of suction, and yet the name is not applied, because the principle by which the mercury is sustained is so generally understood. A perfect vacuum is never obtained in a water barometer for two reasons, and the first is that water evaporates in a vacuum, and further, it either contains air or carbonic acid in solution that it disengages in the vacuum; further, it rapidly absorbs air in a peculiar manner, by a sort of convection. Any kind of water may be used, say distilled water, but after the barometer has been set going with this for a short time, it is found that the water in the trough at the bottom of the column soon becomes saturated with air and that this air is passed on from molecule to molecule, until it ultimately reaches the top of the tube and is there disengaged, and reduces the elevation of the water column. The water barometer acts on the same principle as a mercury one, the only difference being that the lengths of the columns are inversely as the specific gravities of the fluids employed, for instead of a column of 30 inches as in the mercury barometer the water barometer requires a column of practically 34 feet, for $\frac{14.7 \times 144}{62.4} = 33.923$ feet. The tube for the mercury barometer is made of glass, but only a portion of the tube for the water barometer is made of glass, the reason of the difference being the great length of the latter. The lower portion of the tube consists of 30 feet of iron or brass piping and mounted on the top of this is usually a 6 foot glass tube that is connected to the middle pipe with the water and the air-tight joint. As may be readily supposed, the water barometer cannot be filled like the mercury one, for with this great length of tube an inversion process is impossible; it is, therefore, furnished with two faucets, one at the bottom and one at the top. To fill the tube, the bottom faucet is shut and the top is open, when the water is run in with a funnel. For reading the barometer the top faucet is shut and the bottom one opened and then the elevation at which the top level of the column comes to rest is an index of the pressure of the atmosphere. There are a few matters, however, that occur during the filling of the water barometer that are interesting as occurrences that take place in the siphon, and in the tail pipe of a pump; for example, at the period when the bottom faucet is open, and the top one shut for reading the water barometer, a perfect stream of air globules is seen to be rapidly rising in the column, and further, as the stream of air upflows, the water column is observed to shorten as a consequence of the disengaged air rapidly destroying the vacuum. A few experiments with a water barometer will furnish correct ideas of the causes of the troubles that arise in the working of pumps and siphons, thus:

1. If the tube of a water barometer be filled with freshly made distilled water the reading, if the tube is perfectly air tight, will be about 1 foot less than the theoretical height, the fall in this case being due to the tension of the vapor of water that always forms in an approximate vacuum.

2. If the tube of the water barometer be filled with distilled water that has been for some time exposed to the air, the reading will show a shorter column than the one of the former experiment, the reason being the distilled water during its exposure has absorbed some air, and a portion of it has been disengaged by the water at the top of the column.

3. If the water barometer be filled with water that is saturated with carbonic acid gas, and be observed through the glass tube, the moment the top faucet is shut, and the bottom one is opened, a stream of gas globules will ascend, and in doing so many of them will adhere to the sides of the glass tube. By this disengagement of gas the water column will be seen to drop below the range of the glass tube and out of sight. Another interesting fact will be observed in this experiment, that is, the rate of fall will be a decreasing one; for example, the time of the fall of the first 2 feet will be much shorter than that of the second 2 feet, and so on.

4. If the tube be filled with water saturated with sulphureted hydrogen gas, the disengagement of gas will be more rapid than in the case of carbonic acid gas, and in consequence of this, the fall of the column will be quicker, and ultimately no water will be left in the tube.

5. If the tube be filled with hot water having a temperature varying from 160° to 200° F. when the top faucet is closed and the bottom one is opened, the water will be seen for a moment to boil and drop suddenly out of sight. In this case the formation of steam is the result of the boiling temperature having been reduced by the reduction of pressure.

6. If the tube be filled with hot water it may be observed that as the temperature declines the length of the column increases. Now apply heat to the lower portion of the metallic tubing, when it will be found that as the temperature increases the length of the column shortens, the reason being that the tension or pressure of the vapor increases as the temperature of the water increases, and decreases as the temperature decreases, or otherwise expressed, the vapor has a specific temperature for every gradation of pressure.

These and other experiments of like kinds show the causes of many changes in the action of pumps and siphons, since the water barometer, the siphon and the pump have a common mode of action, in so far as the pressure of the atmosphere and a depression or approximate vacuum is concerned.

Coal Mining in Illinois, 1898.

Mr. David Ross, Secretary Bureau of Labor Statistics, says that returns from the seven mine inspection districts show that the total coal production for the year ended June 30, 1898, was 18,599,299, or, in round numbers, 1,500,000 tons less than that reported for 1897. This shortage is accounted for when the magnitude and the duration of the suspension of last year is considered. It is probably a smaller shrinkage than would have been expected. It is explained by the fact that, while many mines were idle, a few were running night and day, and by the further fact that, after the suspension, all mines resumed operations with unusual activity.

An inquiry into the productive capacity of the 811 mines in the State

develops the fact that with present equipment, figured on the basis of full time, these mines are capable of producing nearly 42,000,000 tons of coal, or 120 per cent. more than the actual output for the present year. Assuming that the normal output for this year would have been something over 20,000,000 tons, it appears that the capacity of the mines of this State is equal to fully twice the demand for their product.

The average running time of the shipping mines for the year is found to have been 174.7 days each, while that of the preceding year was 185.5 days. This difference is also less than might have been expected. It is not, however, inconsistent with the decline in tonnage, which was only 7.5 per cent., while that for days of active operation was 6.4 per cent.; both confirm the excessive activity subsequent to the suspension. A comparison of average values for the last two years shows, for the first time in many years, a slight reaction from the tendency to lower prices, which has so long prevailed. The average value of all coal at the mine, as computed for the State for 1897, was 85.2c. per ton, the lowest ever reported in the State. For 1898 a corresponding average is found to be 91.8c. per ton, and since the close of the year for which this report is made the demand for coal has been firm at advancing prices.

In the matter of prices paid for mining—or the wages of miners—the suspension accomplished a material increase throughout the State, which is approximately expressed by the figures 34.26c. per ton for 1897, and 40.09c. per ton for 1898. These are the averages computed for all gross weight mining for the past ten years. It is impossible to make exactly parallel averages, owing to the establishment, now for the first time, of a uniform gross weight basis.

An observable feature is the recent increase in machine mining. During the year the number of mines in which machines are used has been increased by 12, and the number of machines in operation by 72. This new interest in mechanical coal cutting is accountable for in part by the impression that the mining rates as fixed by State conferences are specially favorable to machine mining, and partly by the degree of efficiency which is being developed by modern electrical machines.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE gas properties of the Ottumwa (Iowa) Gas, Light, Heat and Power Company have been purchased by the syndicate headed by Mr. Rufus C. Dawes, President of the Northwestern Gas Light and Coke Company, of Evanston, Ills. Mr. H. B. Maynard, of Washington Court House, Ohio, has been appointed Manager of the Ottumwa concern.

AT the annual meeting of the Chambersburg (Pa.) Gas Company the following officers were chosen: Directors, S. M. Linn, A. Duncan, T. McDowell, F. Lindsay, I. Stine, W. U. Brewer and M. C. Kennedy; President, S. M. Linn; Secretary and Treasurer, H. Gehr; Superintendent, A. C. McGarth.

MR. C. H. CARTER has been appointed Superintendent of the Clarksville (Tenn.) Gas Light Company.

THE authorities of Memphis, Tenn., propose to move in the matter of appointing an official inspector of gas and meters for the city, under the ordinance passed October, 1895.

MR. C. H. NUTTING has been named to succeed Mr. Walter P. Elliot as Manager of the Chicopee (Mass.) Gas Light Company. Mr. Elliot will shortly go to Little Rock, Ark., where he will supervise the rehabilitation of the Pulaski Gas Light Company, which concern was recently taken over by Mr. H. Allan Odell and Mayor Quincy, of Boston, and their associates.

MR. WALTER G. AFRICA, Treasurer and Superintendent of the Peoples Gas Light Company, of Manchester, N. H., has been authorized to issue the following notice:

"We hereby announce to present and prospective consumers of gas that beginning with bills for January consumption, the price of gas will be as follows: Gross price per 1,000 cubic feet, $1.40; discount for prompt payment—on or before 6th of month—15 cents, or $1.25 per 1,000 cubic feet net. We continue to make free street and meter connections; that is, no charge is made for connections from the street mains to the house pipes. Gas stoves are sold at cost and connected free of charge."

AT the annual meeting of the Lebanon (Pa.) Gas Company, a semi-annual dividend of 4 per cent. was declared. The officers chosen were: Directors, Anthony Aurentz, Rudolph Behm, H. C. Grillinger, J. P. S. Gobin, C. H. Killinger, J. W. Mish and L. E. Weimer; President, L. E. Weimer; Secretary, J. W. Mish; Solicitor, Chas. H. Killinger.

WRITE to the Davis & Farnum Manufacturing Company, of Waltham, Mass., for a copy of their handsome calendar for the current year.

MR. CHARLES DUDLEY LAMSON, President of the Worcester (Mass.) Gas Light Company, replying to the questioning of a reporter for a local newspaper, said some days ago that there was positively not a word of truth in the report that the Light, Heat and Power Company, of Boston, was negotiating for the purchase of the Worcester Gas Light Company. Mr. Lamson further said that his Company had not even been approached by the Light, Heat and Power Company with a proposition for purchase.

AT the annual meeting of the Omaha (Neb.) Gas Company the officers chosen were: Directors, Frank Murphy, George E. Barker, B. B. Wood, Randall Morgan and Samuel T. Bodine; President, Frank Murphy; Vice-President, George E. Barker; Treasurer, Isaac Battin; Secretory, G. W. Clabaugh.

MR. W. H. SWINDELL, General Superintendent of Lamps and Lighting for Baltimore, Md., has presented his report for the public lighting of Baltimore to Mayor Malster, for the twelvemonth ended December 31, 1898. According to his presentment there are now in use lamps of three kinds and numbers: Arc electric, 1,317; gas lamps, 5,291; gasoline lamps, 334—in the city proper. In the district known as the annex the distribution of the lamps is: Electric arc, 52; gas, 944; gasoline, 738. This tabulation means a total of 8,676 lamps, which serve in a way to illuminate something over 800 miles of streets and highways. The total cost of the lighting amounted to $399,550.19. Mr. Swindell believes or estimates that the lighting for 1899 will require the expenditure of $442,000. Respecting the general working of his office, and commenting on what may or may not be done therein, he says: "There is no contract with the Gas Company. I find that the city has been compelled to pay the same price for gas as the private consumer since 1885. The present price is $1.25 per 1,000 cubic feet. Owing to the city being such a large consumer, and that the expense of distribution is so *small*, it seems that the price should be somewhat reduced. I would suggest that if a contract is made with the Gas Company the price be per lamp, burning upon schedule to be arranged by the general Superintendent of Lamps, instead of using a few gas meters scattered throughout the city, as at present, as it is well known that the mechanism of the gas meter is affected by the changes of temperature, thus causing a variation in the registered consumption from the actual consumption, necessitating a settlement by equity, instead of a fixed charge. Also that authority be given the General Superintendent of Lamps to order the Gas Company to lay mains, as there are times when it is desirable to erect gas lamps, but there is no authority to order mains laid. The gas lamps supplied with the improved Welsbach fixtures have given entire satisfaction. The contract for the same expires March 1, 1900. As the improvement in the light is greatly increased over that from the lava tip burners, I think it would be well to increase this character of service, provided the contract can be made at a lower figure. The price paid at present is $12 per annum. While the total cost of the maintenance of the lamps supplied with these fixtures does not exceed that of those with lava tips, there is an increase in the illumination from 25 to 60 candle power. Gasoline lamps are in service only where there are no gas mains. As soon as mains are laid gas lamps supplant the gasoline. There is more or less trouble in windy weather to keep the gasoline lamps burning; consequently the change is made to gas as soon as possible, thereby improving the service. During the past year the Department has made much less trouble with boys breaking the lamps and street signs than heretofore. As soon as any trouble is encountered by the Department the police authorities, upon request, apprehend the offenders. The consumer of gas, it appears, does not know that upon payment in advance to the inspector the specified fee of $1 the inspector will send to the premises, remove the meter to the office, inspect the same, and if it is found registering more than 2 per cent. against the consumer his $1 will be refunded, and the gas company will refund the amount of overcharge on the last four months preceding the test."

MR. CHARLES L. NELSON has been appointed Manager of the Bloomfield and Montclair divisions of the properties of the Essex and Hudson Gas Company, of Newark, N. J., vice Mr. Albert E. Forstall, resigned.

THE Fitchburg (Mass.) *Star* says that the Light, Heat and Power Company of Boston will encounter a tough proposition in its attempts to buy up the Fitchburg Gas and Electric Company. Mr. Henry F. Coggshall, Treasurer and General Manager of the Fitchburg Company, when asked by a reporter if the Boston corporation had made any overtures looking to the purchase of the former, replied, "No, it has not; neither can it be bought, for the plants are not for sale."

AT a meeting of the Directors of the Spencer (Mass.) Gas Company a proposition for the sale of its property to the Light, Heat and Power Company, of Boston, was considered. The Directors voted, after a lengthy discussion, to sell, "provided a satisfactory price could be obtained." The negotiations were entrusted to the care of the Company's President, Mr. Luther Hill.

MR. JAMES M. RATCHFORD, night engineer for the St. Paul (Minn.) Gas Company, died suddenly while on duty in the engine room, at an early hour of the morning of December 30th. Deceased was born in Ross, Canada, Jan. 2, 1851, and had been in the service of the Gas Company since 1892. Prior to this he had been a locomotive engineer on the Northern Pacific Railroad.

A CORRESPONDENT forwards the following from the Pittsburg (Pa.) *Commercial Gazette*, under date of the 5th inst.: "An important opinion affirming the judgment of the lower court was handed down today. It related to the suit of the McKeesport Gas Company and others vs. the Carnegie Steel Company, Limited, to restrain the defendant Company from dumping slag into the Monongahela river. In February, 1897, there was an extraordinary flood in the Monongahela and Youghiogheny rivers, flooding the manufacturing plants of the plaintiffs and the wharfs, sewers and some of the streets of McKeesport, stopping operations in the manufacturing plants for two days, and rendering the streets flooded impassable. In the bill it was charged that the defendant Company had caused an increased flooding of the property of the plaintiffs by the erection of buildings and deposit of refuse material in the river opposite its property. The defendants claimed that the river at McKeesport had been narrowed by fills and obstructions made by the plaintiffs, and that any damage sustained on account of high water was due to the acts of the plaintiffs. Judge J.W. F.White, who heard the case, decided it in favor of plaintiffs, remarking as follows: 'For 40 years or more the furnaces, iron works and factories and some railroads have been pushing out the banks of our rivers and contracting the currents, thus increasing the height of the water during floods and the swiftness of the currents. The evil is yearly augmenting. This defendant Company has made some incroachments upon the river, but trifling when compared with some others. It would be unjust to punish it severely when much greater sinners go unpunished. It will be sufficient to prevent further incroachments.'"

ADVICES respecting Covington, Ky., by way of Cincinnati, Ohio, are to the effect that proceedings would be instituted forthwith by the Covington Gas Company against the city of Covington, Ky., in a suit for pecuniary damages, sustained by reason of the Suburban Electric Company of Covington failing to fulfill its contract to purchase the gas plant and pay therefor $486,000. In the petition demanding damages the Gas Company proposes to show that the city, by reason of its agreement with the Suburban Electric Light Company, cut off the use of gas as furnished by the Gas Company from Madison avenue and Pike street, and from the city buildings. The Gas Company will also allege that, under duress, it was compelled to procure and pay half the expense of a Board of Appraisers; that the Board was an expensive one, and that by these actions forced upon the Gas Company the value of its stock was materially diminished. The plaintiff will also contend that a *bona fide* offer was made by Hugh McDonald, accompanied by $5,000 cash, for the privilege of purchasing the gas plant at appraised value. This offer was declined, and the contract or purchasing power awarded to the Electric Light Company without any money consideration being involved. The Gas Company will also hold that the city of Covington is alone responsible, as the Gas Company had no dealings with the Suburban Electric Light Company. This suit will naturally cause the city to institute similar proceedings against the Electric Light Company on the bond given by it for $40,000 for a faithful fulfillment of its part of the contract.

THE decision handed down some days ago by Judge Peckham of the United States Supreme Court, in the case of the United States against the Buffalo Natural Gas and Fuel Company, affirms a decision made by Judge Coxe in March, 1896. The case was appealed by the plaintiff to the United States Circuit Court of Appeals and thence to the Supreme Court, which has now affirmed the original decision. An application was made by the Collector of the Port of Buffalo for a review of the decision of the Board of General Appraisers, sustaining the protest of the importer, and holding that the natural gas brought into this country by pipe line under the Niagara river is a crude mineral, and therefore exempt from duty. The question had twice been before the Board of Appraisers. The first decision was delivered July 10, 1891. It recited the fact that the pressure of the natural gas brought from Canada was about 600 pounds to the square inch and too great for the endurance of any meter. The gas was furnished as fuel to the Buffalo city water works and to large manufactories. The gas was brought by pipes under the Niagara river to Buffalo, a distance of 12 miles. The product was assessed for duty by the Collector at 10 per cent. under Section 4 of the existing tariff. The importer protested, claiming that natural gas was free from duty under paragraph 496, as a crude bitumen, or that it was free from duty under paragraph 651, as a crude mineral. The first decision by the Board of Appraisers sustained the collector and held that the gas was dutiable, alleging among other things that it came into competition with American gas and coal, and that another company was laying a large main across the Niagara river to connect with the Canadian wells. The second decision was made by the Board of Appraisers, May 20, 1893. At this time the Board reversed its previous decision and ruled that natural gas was a crude mineral, the reason for the reversal being additional evidence adduced on the point; a number of well known geologists and chemists being examined. Judge Coxe in his decision said the Court saw no reason to disturb the decision of the Board. His decision concluded as follows: "Had it been the intention of Congress to impose duty upon this volatile, invisible and imponderable product of nature, which is incapable of being gauged, measured or entered at the custom house as are other imported articles, it is difficult to believe that it would have been left to the 'catch all' clause in question. Although the record does not show that natural gas had been imported into this country prior to the act of 1890, it does show that it was well known at that date and had been an article of commerce for years and, of course, might at any time be brought to the United States from Canada or Mexico. Is it not fair to presume that had the lawmakers believed it subject to duty, some definite provision would have been made for it in the statute? Even conceding the question to be doubtful, the doubt should be resolved in favor of the importer. The decision of the Board should be affirmed."

UNDER the consolidation at Memphis, Tenn., the plant of the Equitable Company will be shut down. All the gas will be made at the works of the New Memphis Gas Light Company, the plant of which will be enlarged the coming spring."

MR. MERRIFIELD, of the Economical Gas Apparatus Construction Company, has reported that the Kelderhouse property is not an available site for the gas plant that the municipal authorities of Buffalo, N. Y., have been talking about constructing. Mr. Merrifield gave two reasons for his decision. First, that it would be difficult to construct suitable foundations, owing to the treacherousness of the bottom; second, that the site is so remote from the center of the city that it would be necessary, in all probability, to insure good distribution, to construct two large holders in the city proper.

New Specifications for Wire Coverings and Fittings.

The *Electrical World* says that at the annual meeting of the Electrical Committee of the Underwriters' National Electrical Association, which was held in New York city on December 6, 7 and 8, a special committee was appointed to draw up specifications for wire coverings, to compile a list of fittings acceptable for use under the rules and to take up other matters in connection with the National Electrical Code. This committee will hold a meeting at the offices and laboratory of the Electrical Bureau of the National Board at 157 Sa Salle street, Chicago, beginning January 9. Manufacturers of insulated wire have been invited to be present at certain hours during the meeting when the experimental records of their products will be brought up for consideration and discussion. The following proposed specifications for rubber covered wires, prepared by the electrical bureau, will come up for action:

40. *Wire Insulation.* (a) *Rubber.*—Insulating compounds containing rubber must conform to or be in excess of the measurements given

(*Continued on page* 85.)

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MONDAY, JAN. 16, 1899.

(*Continued from page* 84.)

in the following table, which shows standard thickness of insulating walls for standard wires and cables:

Table.

B & S.	Mils. Thickness of Wall.	Mils. Diameter over Rubber.
18	.0411	.122
16	.0437	.138
14	.0469	.158
12	.0512	.183
10	.0565	.215
8	.0631	.255
6	.0715	.305
5	.0764	.335
4	.0821	.368
3	.0883	.406
2	.0954	.448
1	.1033	.496
0	.1122	.549
00	.1222	.609
000	.1334	.676
0000	.1460	.752

The above table is based upon the following formulæ which may be applied for conductors larger than No. 0000.

Rubber diameter = $\frac{3}{2}$ copper diameter + 62.

Thickness of rubber wall = $\frac{1}{4}$ copper diameter + 31.

As the dielectric strength of a rubber wall is determined by its thinnest portion, all measurements shall be taken across the smallest diameter of the specimen tested. When depressions are caused by the braid or in process of manufacture, the lower surfaces of the channels caused by these depressions must be taken as the exterior surfaces of the wall. For a correct reading the measuring instrument must just shut out a line of light between the material being measured and the terminals of the instrument.

All of these insulations must be protected by a substantial braided outer covering sufficiently strong to withstand all abrasion it will meet with in practice and sufficiently elastic for all wires smaller than No. 5 B. & S. gauge to admit of the conductor being wound back over itself without injury to the braid.

The completed covering must show an insulation resistance of at least 100 megohms per mile throughout eight weeks' immersion in hydrant water at ordinary temperatures. Each foot of the completed covering must show a dielectric strength sufficient to resist throughout five minutes the application of an alternating e. m. f. of 16,000 volts under the following conditions:

The source of alternating e. m. f. shall be a transformer of at least 1 kw. capacity. The application of the e. m. f. shall first be made at 4,000 volts for five minutes and then the voltage increased by steps of not over 3,000 volts, each held for five minutes until the rupture of the insulation occurs. The tests for dielectric strength shall be made on a sample of wire, 1 foot of which is submerged in a conducting liquid held in a metal trough, one of the transformer terminals being connected to the copper of the wire and the other to the metal of the trough.

The committee is composed of W. H. Merrill, Jr., chairman; J. C. Forsyth, of the New York Board of Fire Underwriters; E. V. French, of the Associated Factory Mutual Insurance Companies; William McDevitt, of the Philadelphia Fire Underwriters' Association; A. M. Schoen, of the Southeastern Tariff Association; J. E. Cole, of the Boston Wire Department; and Edward B. Ellicott, City Electrician of Chicago. Acting with the committee will be E. A. Fitzgerald, of the Underwriters' Association of New York State; A. E. Braddell, of the Underwriters' Association of the Middle Department; J. M. DeCamp, of the Suburban Underwriters' Association; Franklin H. Wentworth, Theodore Varney, W. S. Boyd and Benjamin H. Glover, of the Electrical Bureau, and a number of other officials.

The Market for Gas Securities.

The market for city gas shares was remarkable last week for ups-and-downs, the net tendency being in favor of the downs. Consolidated opened to day (Friday) at 189 and sold to 190, and it is undeniable that the gentlemen behind the throne are doing their best to keep Consolidated down. However, if all things come to those who wait, the waiters with Consolidated need not fear the gentle warfare that those concerned in Amsterdams are waging. The Amsterdam "securities" have also declined somewhat, a fair quotation for the common being 30 to 30¾, with 66¾ to 67½ for the fancy. Other city shares show no particular change.

Brooklyn Union is relatively strong, and the same may be said of Peoples, of Chicago. Bay State, of Delaware, has again been infused. The last injection brings its stock circulation up to $100,000,000. Consumers, of Jersey City, is 85 bid; it would be cheap at 100. Lacledes are somewhat higher, and Syracuse specialties are decidedly weaker. Washington, D. C., is 260 bid, and old Jersey City is 210 bid. If anyone has the latter security for sale we will take all offered at the reported bid price.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

Jan. 16.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$37,730,000	100	189	189½
Central Union, Bonds, 5's.	3,000,000	1,000	105½	106½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	.	108	112
Mutual	3,500,000	100	300	305
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	
New Amsterdam Gas Co.	13,000,000	100	30	30¾
Preferred	10,000,000	100	66¾	67½
Bonds, 5's	11,000,000	1,000	103¼	104
Northern Union, Bonds, 5's.	1,250,000	1,000	94½	95½
New York and East River..				
Bonds 1st 5's	3,500,000	1,000	111	113
" 1st Con. 5's	1,500,000	..	107½	108½
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	.	..
Standard	5,000,000	100	133	138
Preferred	5,000,000	100	152	158
Bonds, 1st Mortgage, 5's	1,500,000	1,000	112	114
Yonkers	299,65	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	142½	143
" " Bonds (5's)	15 000,000	1,000	116	.
Bay State	50,000,000	50	6¾	7
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works..	450,000	100	..	..
" 1st Mtg. 5's	450,000	1,000	..	.
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	92	..
2d " " "	3,000,000	1,000	..	80
Buffalo City Gas Co.	5,500,000	100	16	16¾
" " Bonds, 5's	5,250,000	1,000	93	93½
Central, San Francisco	2,000,000	..	105	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus	1,144,700	100	89	91
1st Mortgage	1,207,000	1,000	101	103½
Consumers, Jersey City	2,000,000	100	85	90
" Bonds	600,090	1,000	102	104
Cincinnati G. & C. Co.	8,500,000	100	203¾	204½
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	.	.
Consolidated, Baltimore	11,000,000	100	68	68¼
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000		..	..
Consolidated Gas Co. of N.J.	1,000,000	100	16	21
" Con. Mtg. 5's	380,000	1,000	75	80
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,560,000	50	65	65½
" Prior Lien 5's	4,546,000	1,000	94¼	94½
Detroit Gas Co., 5's	423,000	1,000	95½	96
" Inc. 5's	31,000	100	.	..
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	75	80
" Bonds	2,000,000	..	88	
Grand Rapids Gas Lt. Co..	1,000,000	50	..	..
" 1st Mtg. 5's	1,125,000	1,000	..	.
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	105	115
" Bonds, 6's	2 650,000	..	106	107
Jackson Gas Co	250,000	50	..	..
" 1st Mtg. 5's	250,000	1,000	..	..
Jersey City	750,000	20	210	..
Lafayette Gas Co., Ind.	1,000,000	100	78	83
Bonds	1,000,000	1,000	90	91
Louisville	2,570,000	50	106	108
Laclede, St. Louis	7,500,000	100	54	54½
Preferred	2,500,000	100	87½	90
Bonds	10,000,000	1,000	107½	108
Madison Gas & Elec. Co.	400,000	100	..	..
" 1st Mtg. 6's	350,000	1,000	..	..
Montreal, Canada	2,000,000	100	200	..
Newark, N. J., Gas Co	1,000,000	..	200	220
Bonds, 6's	4,000,000	..	128	130x
New Haven	1,000,000	25	252	..
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	53½	55
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	111½	112

Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	111½	112
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	240	250
Rochester Gas & Elec. Co.	2,150,000	50	52	..
Preferred	2,150,000	50	103	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	88½	89
St. Paul Gas Light Co.	1,500,000	100	50	52
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,428,000	1,000	80	82
St. Joseph Gas Co.	1,000,000	100	..	..
" 1st Mtg. 5's	750,000	1,000	..	..
Syracuse, N. Y.	1,750,000	100	19¾	21⅛
Bonds	1,612 000	1,000	85	89
Washington, D. C	2,600,000	20	260	..
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	100	85¼	86
Bonds, 5's	3,830,500	-	101¾	102½
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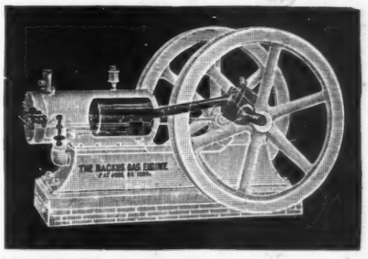

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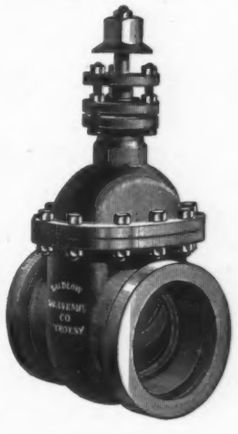

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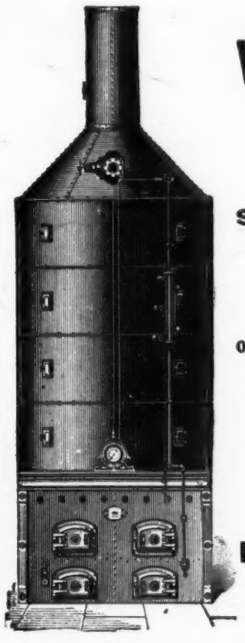

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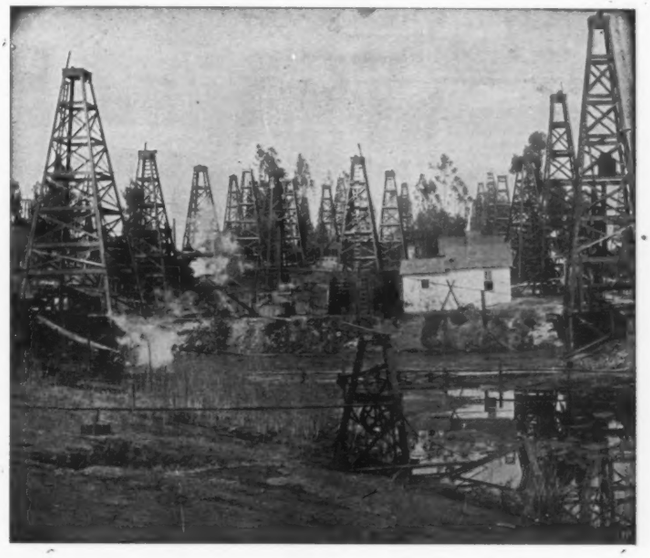

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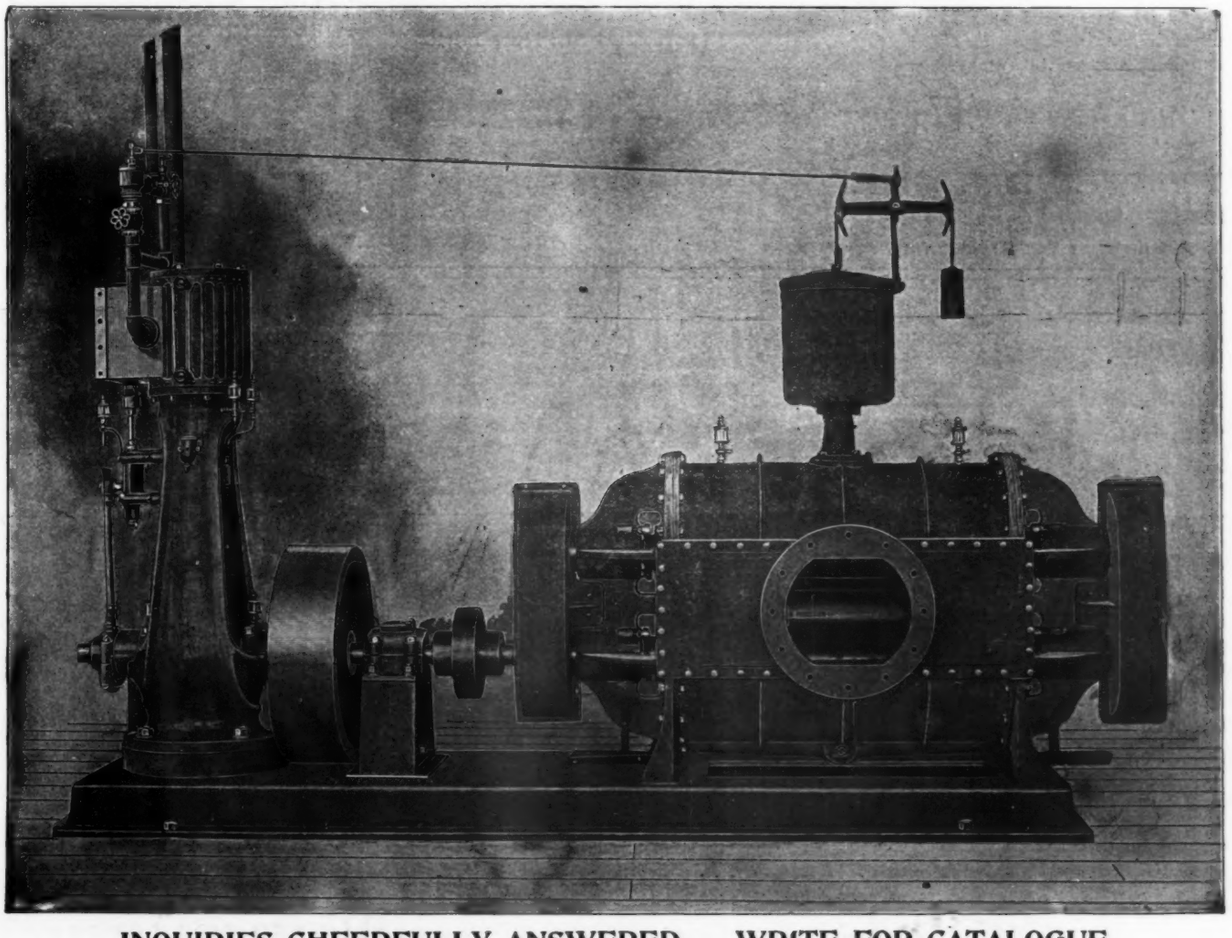

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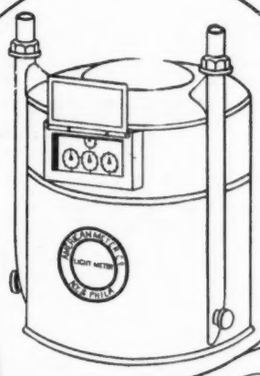

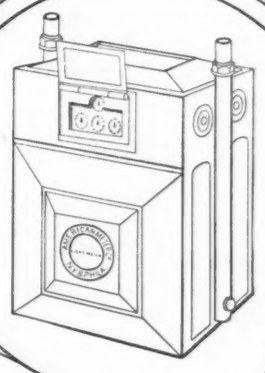

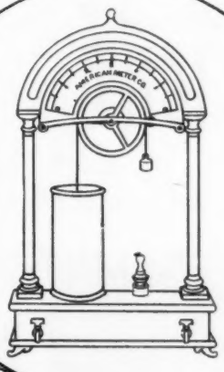

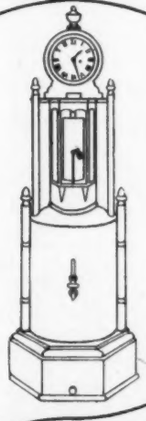

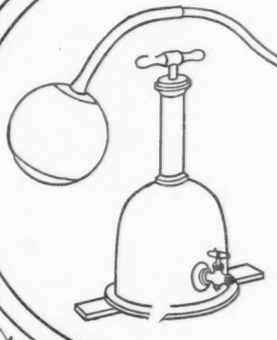

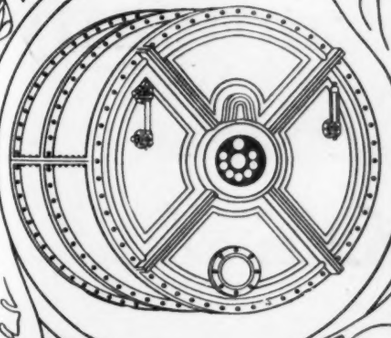

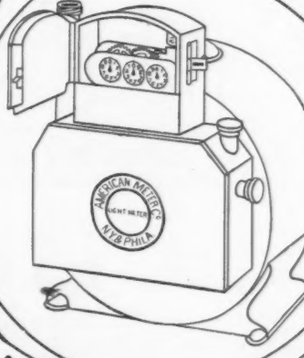

PUBLIC LIGHTING TABLE.

JANUARY, 1899.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Sun.	1	5.20 PM	10.20 PM	4.30	6.30
Mon.	2	5.20	11.20	4.30	6.30
Tue.	3	5.20	12.20 AM	4.30	6.30
Wed.	4	5.20 LQ	1.30	4.30	6.30
Thu.	5	5.20	2.30	4.30	6.30
Fri.	6	5.20	3.40	4.30	6.30
Sat.	7	5.20	4.50	4.30	6.30
Sun.	8	5.20	6.20	4.40	6.30
Mon.	9	5.20	6.20	4.40	6.30
Tue.	10	5.20	6.20	4.40	6.30
Wed.	11	5.20 NM	6.20	4.40	6.30
Thu.	12	5.20	6.20	4.40	6.30
Fri.	13	5.20	6.20	4.40	6.30
Sat.	14	5.20	6.20	4.40	6.30
Sun.	15	5.30	6.20	4.50	6.25
Mon.	16	10.00	6.20	4.50	6.25
Tue.	17	11.10	6.20	4.50	6.25
Wed.	18	12.10 FQ	6.20	4.50	6.25
Thu.	19	1.20	6.20	4.50	6.25
Fri.	20	2.20	6.20	4.50	6.25
Sat.	21	3.20	6.20	4.50	6.25
Sun.	22	4.00	6.20	5.00	6.25
Mon.	23	4.50	6.20	5.00	6.25
Tue.	24	5.20	6.20	5.00	6.25
Wed.	25	No L.	No L.	5.00	6.25
Thu.	26	No L. FM	No L.	5.00	6.25
Fri.	27	No L.	No L.	5.00	6.25
Sat.	28	5.40 PM	8.20 PM	5.00	6.25
Sun.	29	5.50	9.20	5.05	6.15
Mon.	30	5.50	10.20	5.05	6.15
Tue.	31	5.50	11.20	5.05	6.15

TOTAL HOURS LIGHTING DURING 1899.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	215.40	January	423.20
February	184.40	February	355.25
March	187.40	March	355.35
April	166.50	April	298.50
May	158.00	May	264.50
June	140.50	June	234.25
July	150 30	July	243.45
August	168.30	August	280.25
September	179.50	September	321.15
October	213.20	October	374.30
November	217.00	November	401.40
December	238.10	December	433.45
Total, yr.	2221.00	Total, yr.	3987.45

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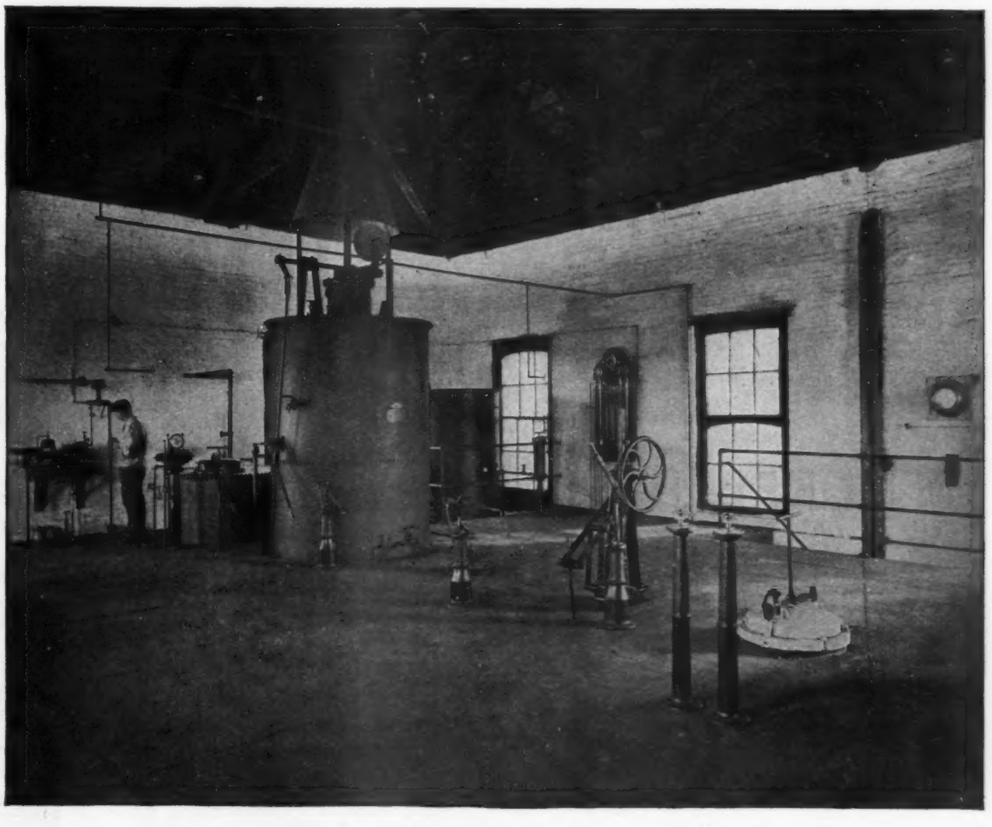

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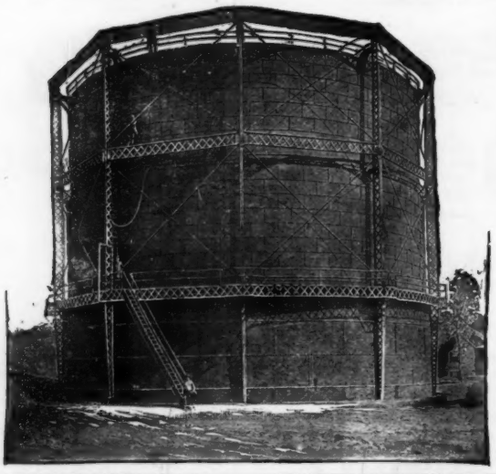

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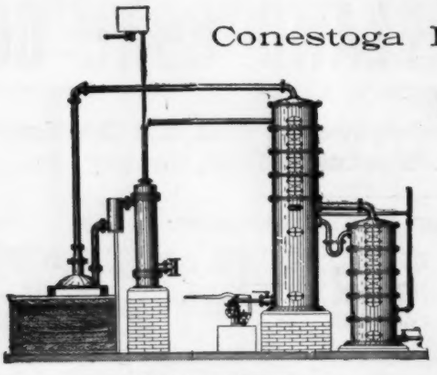

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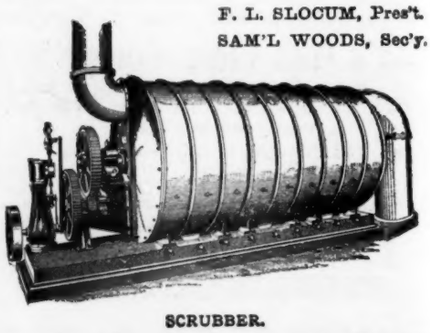

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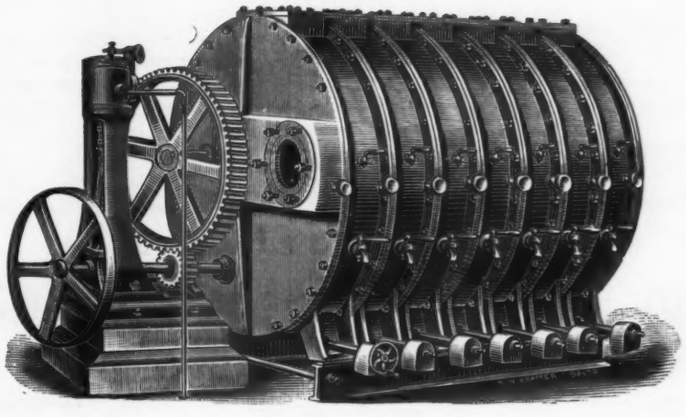

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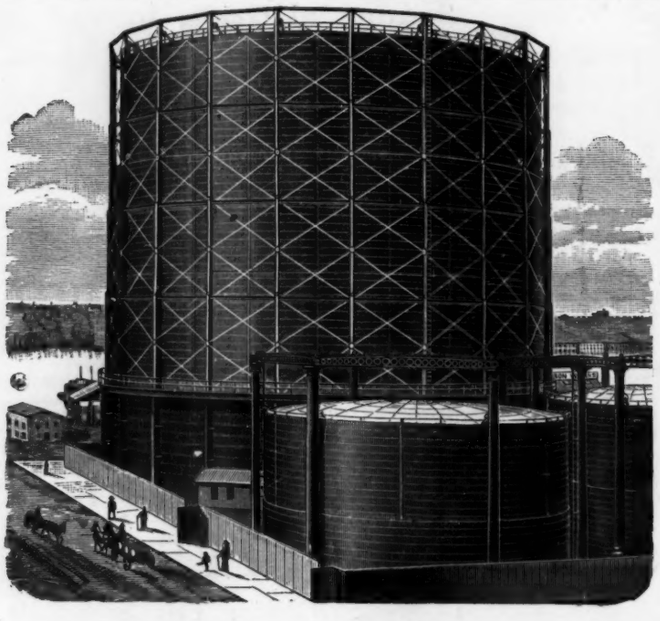

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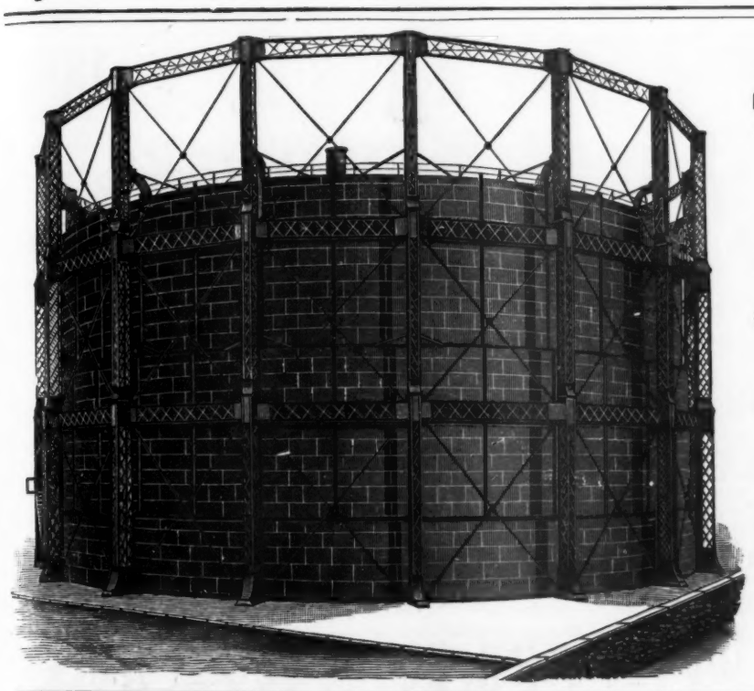

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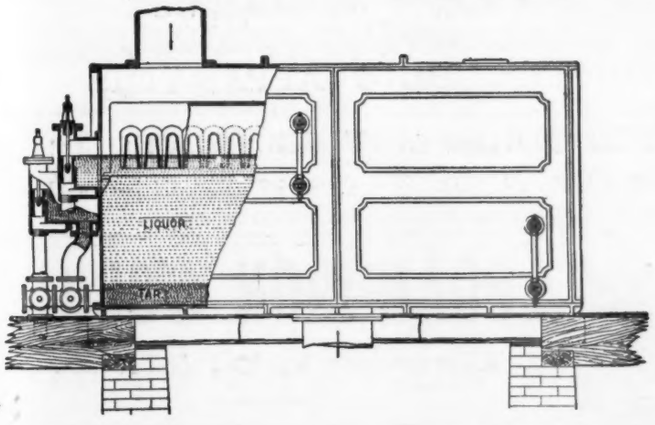

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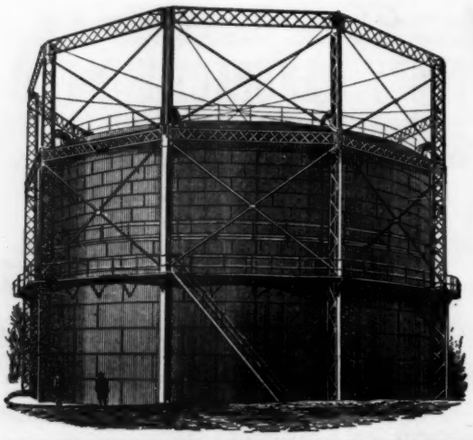

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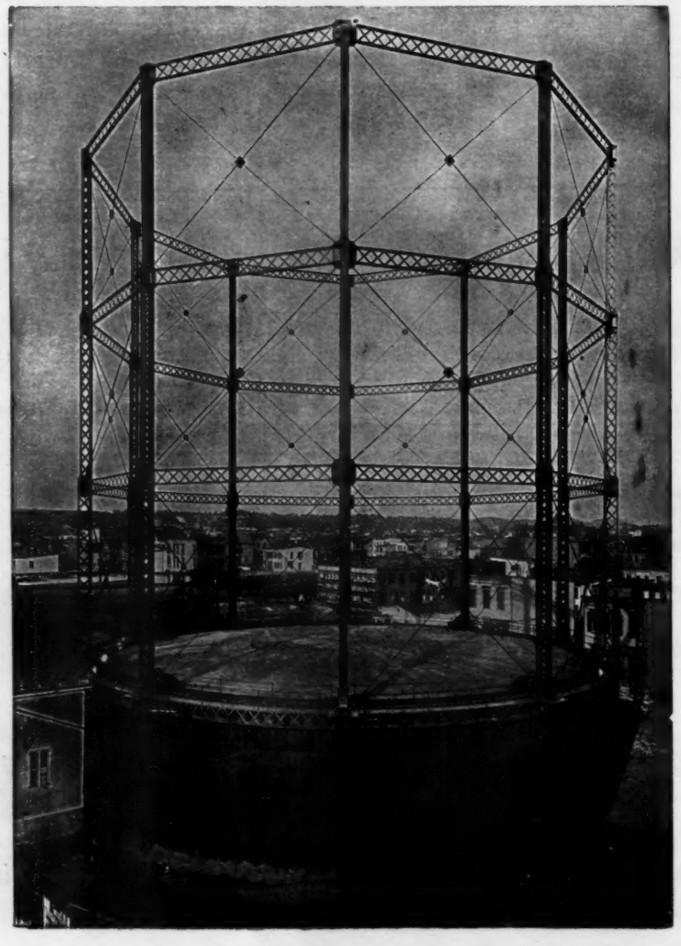

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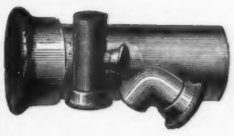

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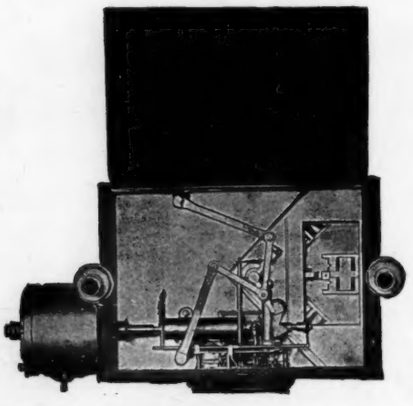

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